Salt Marsh Bibliography

WITH AN EMPHASIS ON THE SALT MARSHES OF CALIFORNIA

Prepared For

California Department of Transportation
Division of New Technology, Materials and Research

Department of Civil Engineering
University of California, Davis
Davis, California
June, 1991

SALT MARSH BIBLIOGRAPHY

WITH AN EMPHASIS ON THE SALT MARSHES OF CALIFORNIA

By

Felix Riesenberg IV
Robert D. Charney
Denise H. Conners
Malcolm A. McEwen
Ray B. Krone
George Tchobanoglous

DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF CALIFORNIA, DAVIS
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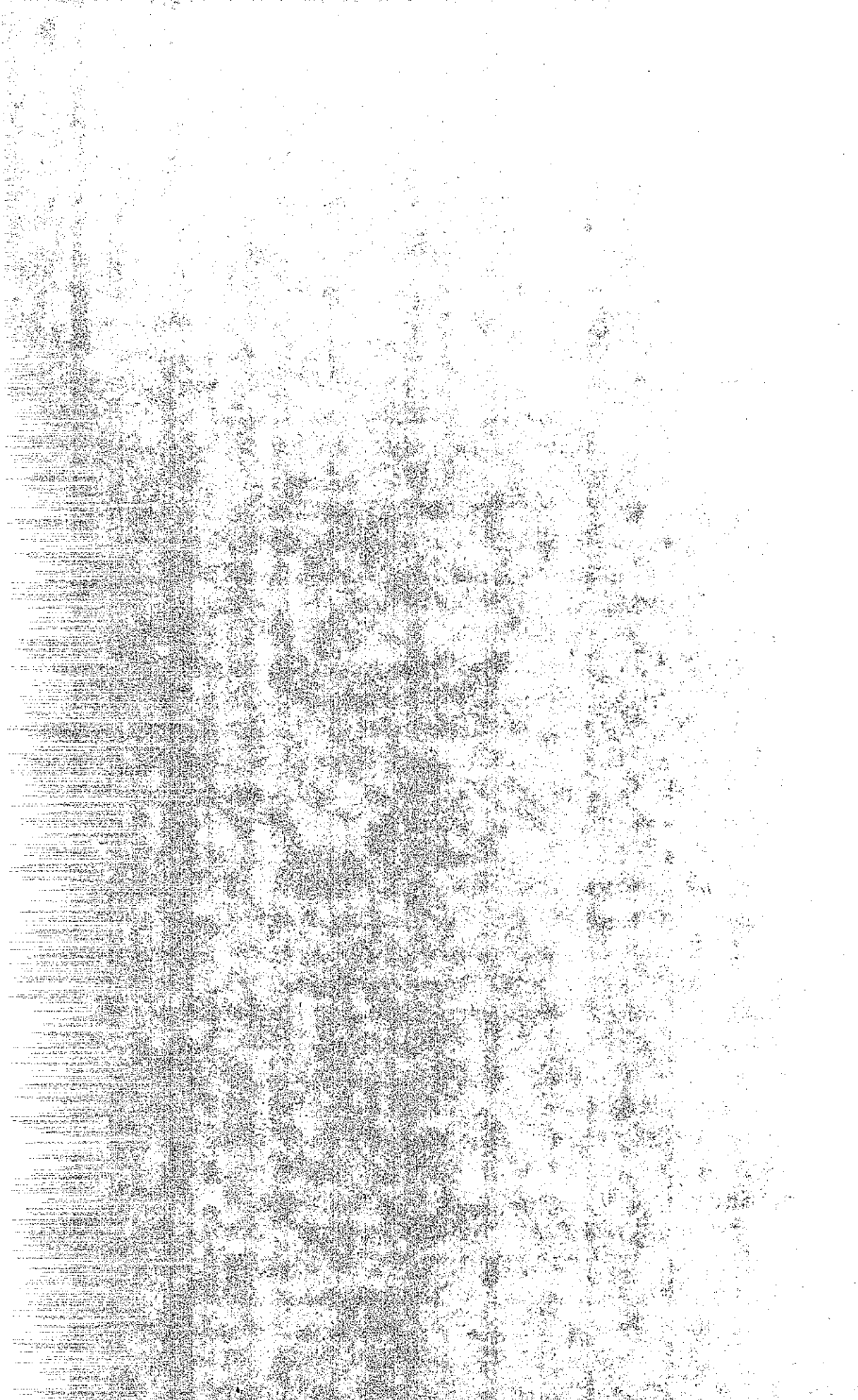

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16. Abstract

Highway construction projects along the California coast can potentially damage adjacent saltwater marshes causing a loss of saltmarsh values. Normally, the California Department of Transportation (Caltrans) tries to avoid these losses by moving highway alignments or other techniques. Occasionally, saltmarsh losses are unavoidable necessitating marsh restoration projects to replace lost saltmarsh values. Considerable information is available from research completed on salrmarsh mitigation, but much of this research has been conducted in States along the East Coast and Gulf of Mexico. Much less specific information is available for California. In this study, 423 books, reports, and articles were reviewed and summarized in an annotated bibilography. The earliest article was written in 1927 and the latest in 1991. The bibligraphy is indexed by author and by keyword and organized chronologically. This report is part of a series of reports on saltmarsh mitigation prepared by the University of California for the California Department of Transportation.

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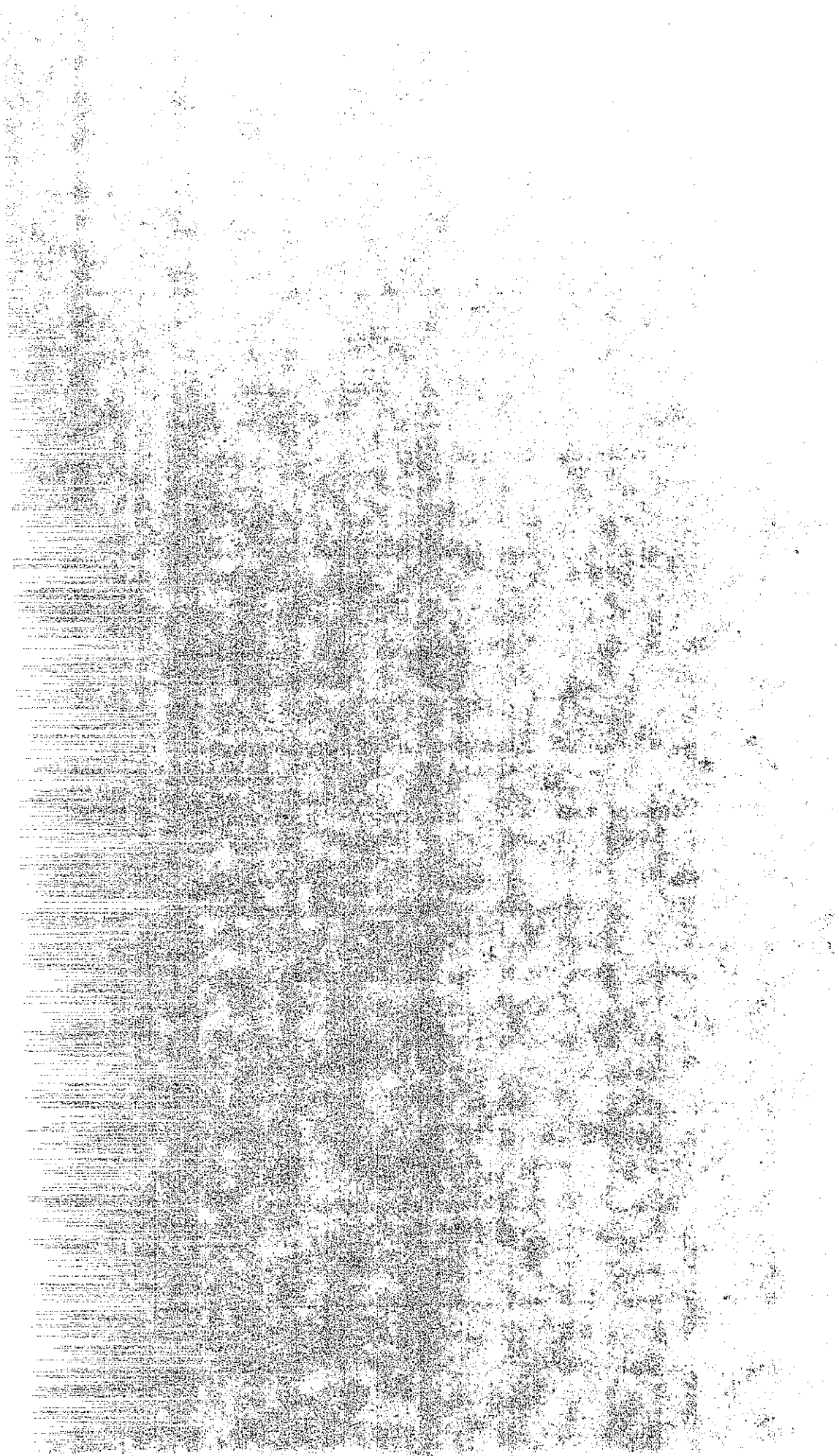
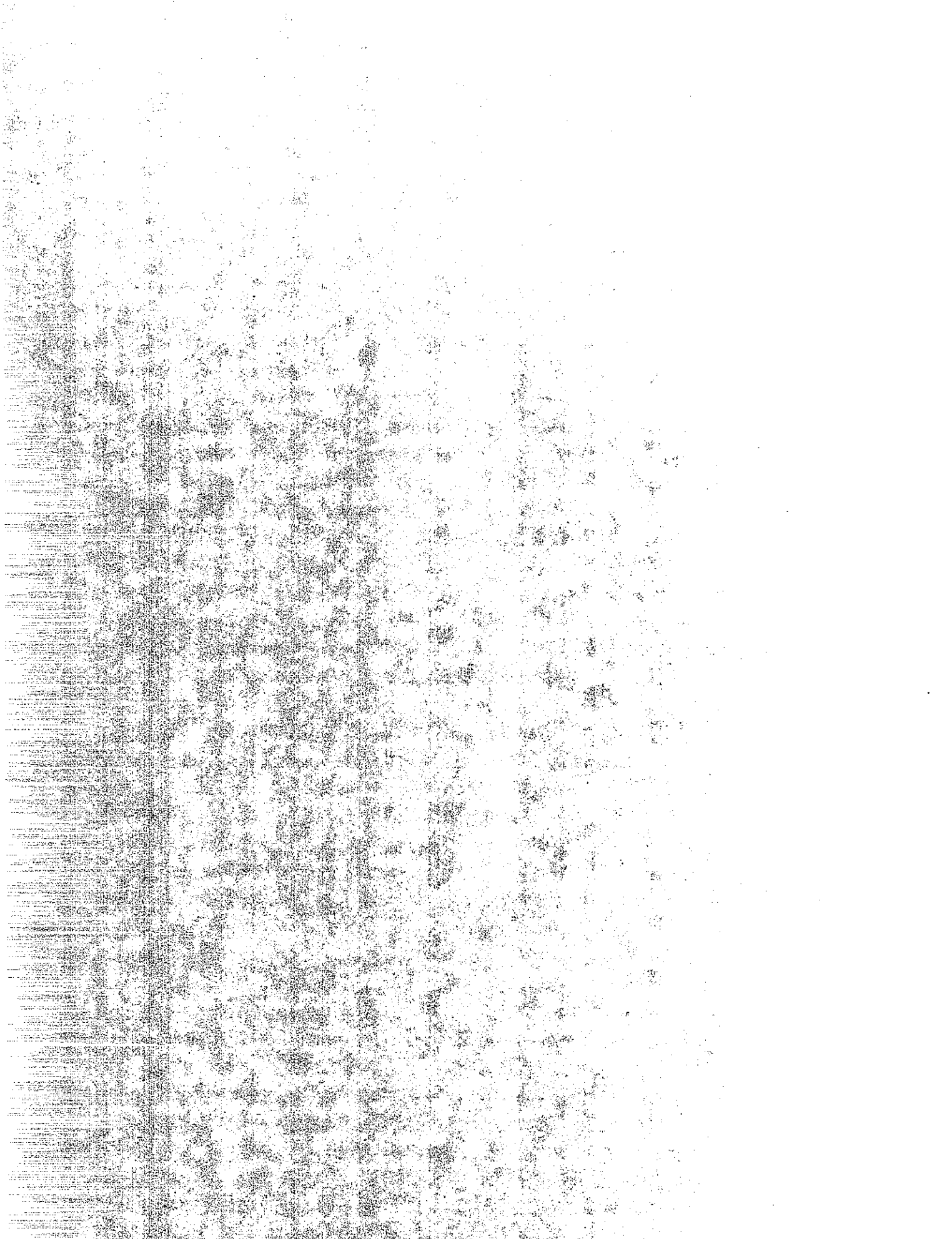


CONVERSION FACTORS

English to Metric System (SI) of Measurement

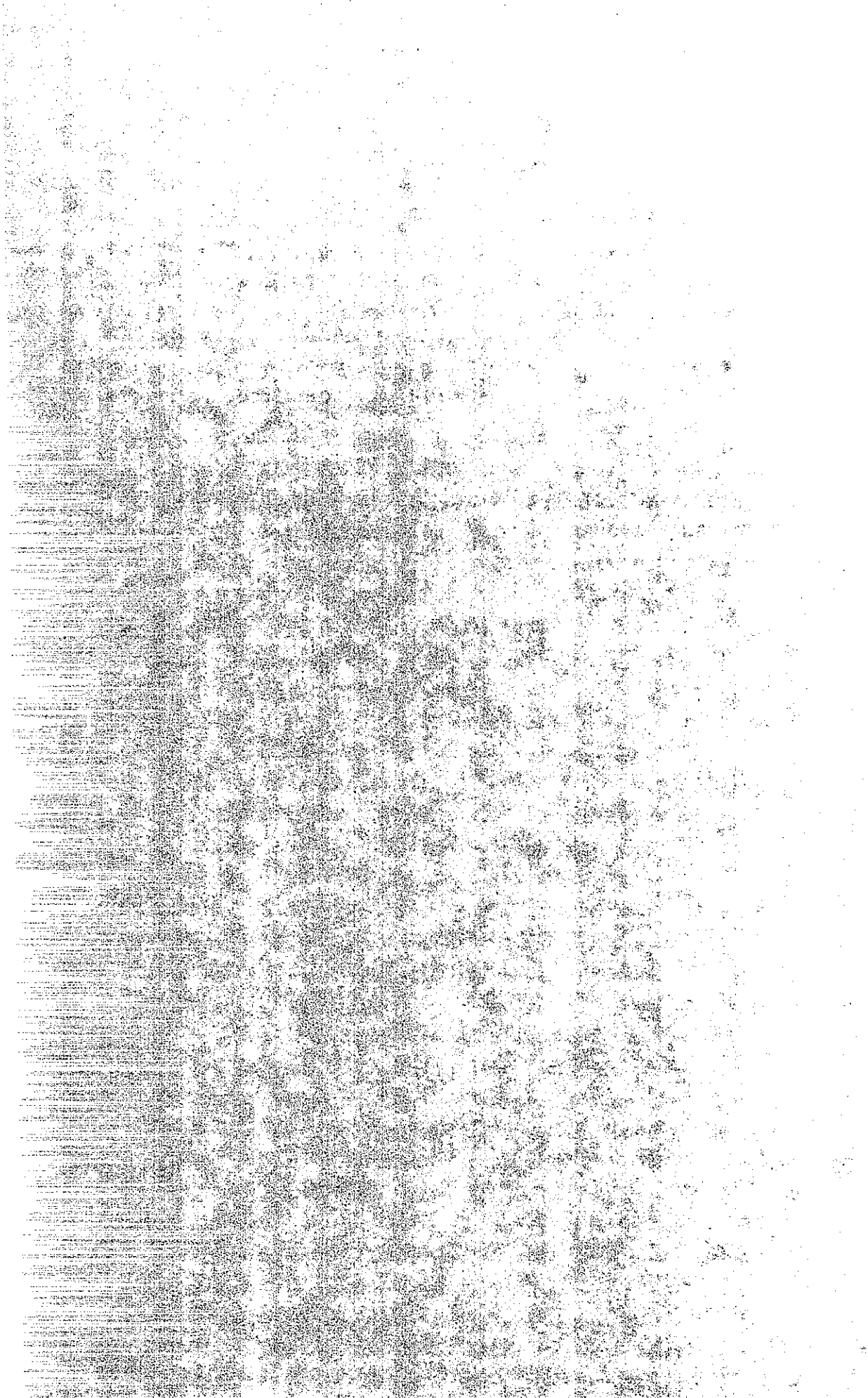
Quality	English Unit	Multiply By	To Get Metric Equivalent
Length	inches (in) or (")	25.40	millimetres (mm)
		.02540	metres (m)
	feet (ft) or (')	.3048	metres (m)
	miles (mi)	1.609	kilometres (km)
Area	square inches (in^2)	6.432×10^{-4}	square metres (m^2)
	square feet (ft^2)	.09290	square metres (m^2)
	acres	.4047	hectares (ha)
Volume	gallons (gal)	3.785	litre (l)
	cubic feet (ft^3)	.02832	cubic metres (m^3)
	cubic yards (yd^3)	.7646	cubic metres (m^3)
Volume/Time (Flow)	cubic feet per second (ft^3/s)	28.317	litres per second (l/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
Mass	pounds (lb)	.4536	kilograms (kg)
Velocity	miles per hour (mph)	.4470	metres per second (m/s)
	feet per second (fps)	.3048	metres per second (m/s)
Acceleration	feet per second squared (ft/s^2)	.3048	metres per second squared (m/s^2)
	acceleration due to force of gravity (G)	9.807	metres per second squared (m/s^2)
Density	(lb/ft^3)	16.02	kilograms per cubic metre (kg/m^3)
Force	pounds (lb)	4.448	newtons (N)
	kips (1000 lb)	4448	newtons (N)
Thermal Energy	British thermal unit (BTU)	1055	joules (J)
Mechanical Energy	foot-pounds (ft-lb)	1.356	joules (J)
	foot-kips (ft-k)	1356	joules (J)
Bending Moment or Torque	inch-pounds (in-lb)	.1130	newton-metres (Nm)
	foot-pounds (ft-lb)	1.356	newton-metres (Nm)
Pressure	pounds per square inch (psi)	6895	pascals (Pa)
	pounds per square foot (psf)	47.88	pascals (Pa)
Plane Angle	degrees (°)	0.0175	radians (rad)
Temperature	degrees fahrenheit (°F)	$\frac{°F - 32}{1.8} = °C$	degrees celsius (°C)
Concentration	parts per million (ppm)	1	milligrams per kilogram (mg/kg)



NOTICE

The contents of this report reflect the views of the Division of New Technology, Materials and Research which is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

Neither the State of California nor the United States Government endorse products or manufacturers. Trade or manufacturers' names appear herein only because they are considered essential to the object of this document.



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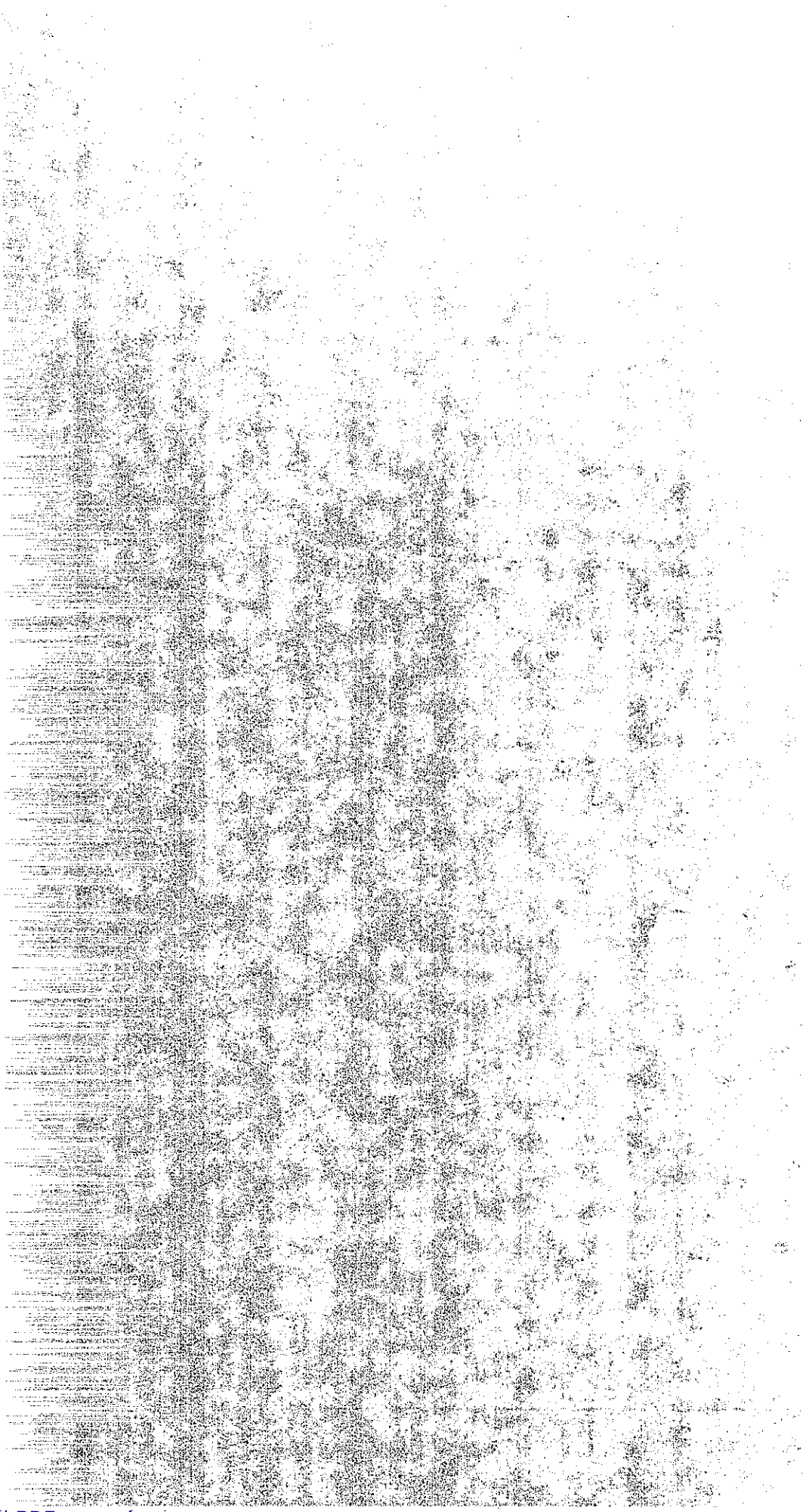
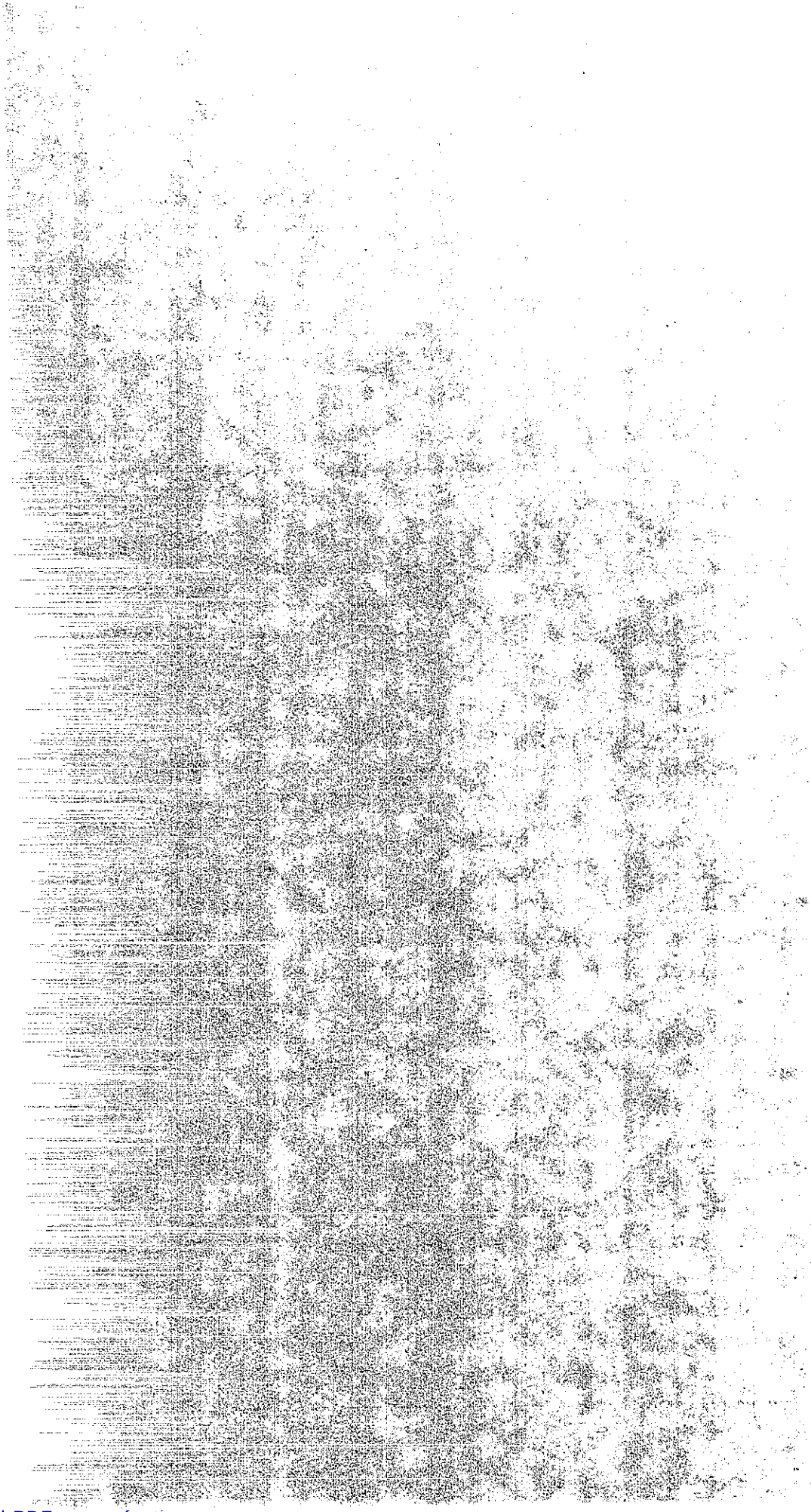




This salt marsh bibliography was prepared for the California Department of Transportation (Caltrans) in conjunction with four salt marsh restoration and creation manuals, and a report identifying research needs. The primary focus of this bibliography is on the literature that is pertinent to Caltrans for salt marsh restoration and creation projects in California.

ORGANIZATION OF BIBLIOGRAPHY

This bibliography includes annotations of a variety of salt marsh literature including books, reports, and articles. To increase the utility of this bibliography, keywords have been included along with an author index and a keyword index. The annotated bibliography is organized chronologically, and within each year, the individual bibliographic entries are organized alphabetically. The numbers preceeding each entry are used with the author and keyword indexes. For example, the number 79-08 is used to denote the eighth article, arranged alphabetically, for the year 1979.

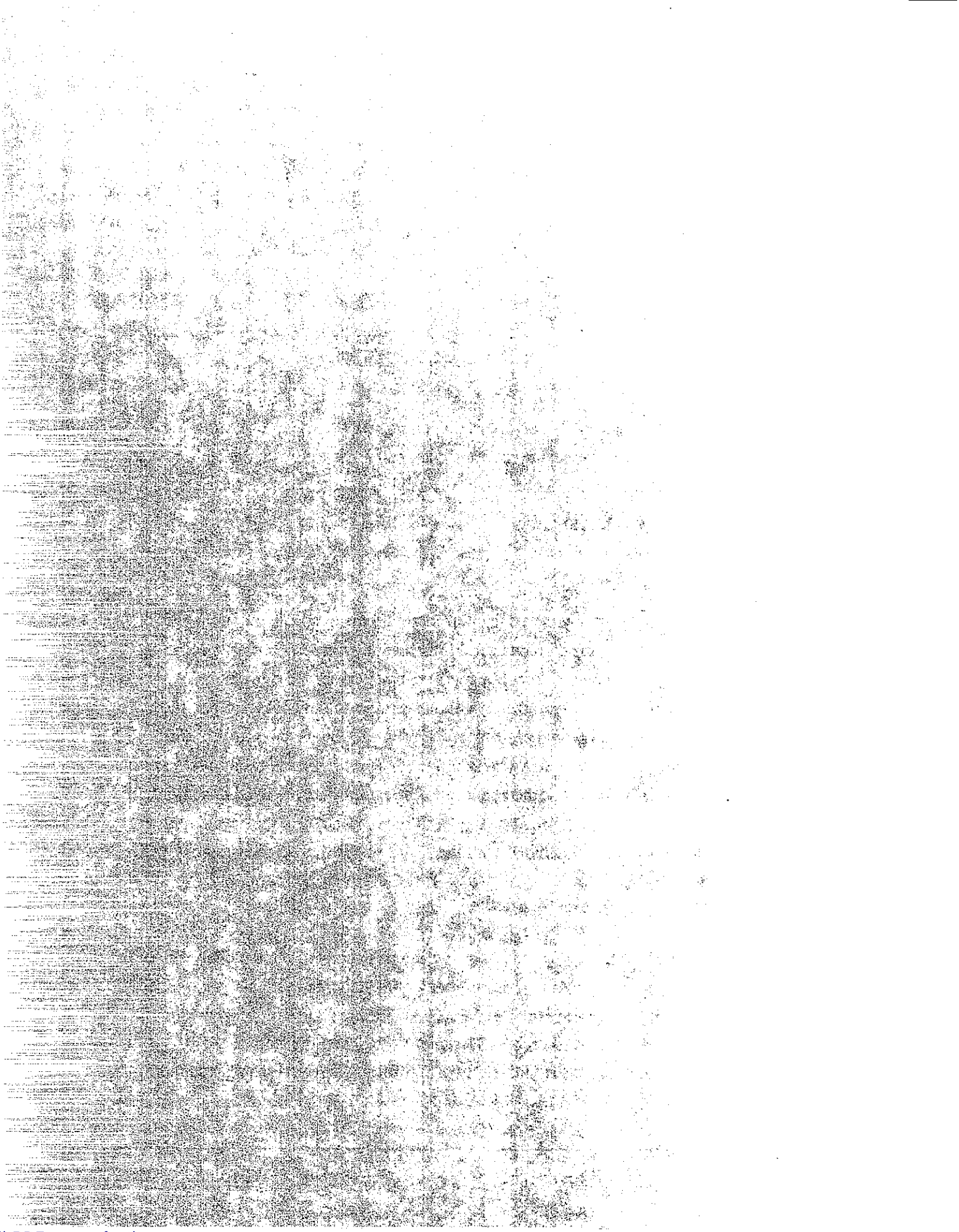
USE OF BIBLIOGRAPHY

This bibliography can be used in the following manners:

- Use the annotated bibliography to become familiar with the available literature and to determine which publications contain useful information with respect to a specific need.
- Use the author index to locate publications written by specific individuals.
- Use the keyword index to find information about specific topics. If it is desired to locate publications with a combination of keywords, e.g., San Francisco Bay and marsh restoration, it will be necessary to search both keyword index topics and look for identical numbers. Alternatively, the annotated bibliography can be used in conjuntion with one of the index topics. Using one keyword index topic, find the article number, then refer to the keyword list included with the article to see if all the desired keywords are listed for the given entry.

ACKNOWLEDGMENTS

The completion of this bibliography would not have been possible without the cooperation and assistance of numerous individuals. The authors would also like to thank Messrs. Bennett John, Jeffrey Gidley, Harold Hunt, and Pete Zaniewski of the Caltrans Division of New Technology, Materials, and Research in Sacramento, CA, and the staff of the Department of Civil Engineering at the University of California, Davis. Financial support was provided by Caltrans.



00-01. U.S. Department of Commerce (date unknown), "Our Restless Tides," National Ocean Survey, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C.

A brief introduction to tides is provided in the pamphlet in an easy to understand format.

Keywords: tides, hydrodynamics

27-01. DeGroot, D.S. (1927), "The California Clapper Rail: Its Nesting Habits, Enemies, and Habitat," *The Condor*, vol. 29, pp. 259-270.

The nesting habits and habitat of the California clapper rail are described based on numerous field studies. Several causes of the clapper rail's declining population are also discussed.

Keywords: San Francisco Bay, birds, endangered species

35-01. MacGinitie, G.E. (1935), "Ecological Aspects of a California Marine Estuary," *The American Midland Naturalist*, vol. 16, no. 5, pp. 629-765.

The ecological aspects of Elkhorn Slough (Central California) are documented in the article. Lists of the plant and animal species collected are provided.

Keywords: Central California, ecology, tidal marsh

42-01. Purer, E. A. (1942), "Plant Ecology of the Coastal Salt Marshlands of San Diego County, California," *Ecological Monographs*, vol. 12, pp. 81-111.

The results of an ecological survey of 12 saltwater marshes in San Diego County, California are included in the article. Monthly soil water and surface water salinities between January 1939 and May 1940 are reported. Detailed studies of nine principal plant species found in the marshes are also presented including information on zonation and natural propagation.

Keywords: Southern California, tidal marsh, plant establishment, salinity, hydrodynamics, plant ecology

51-01. Marmer, H.A. (1951), "Tidal Datum Planes," Special Publication no. 135, Coast and Geodetic Survey, U.S. Department of Commerce, Washington, D.C.

An explanation of tidal datum planes is included in the publication. Detailed examples of methods used to calculate datums are also included.

Keywords: tides, hydrodynamics, sea level rise

58-01. Defant, A. (1958), "Ebb and Flow," The University of Michigan Press, Ann Arbor, Michigan.

Information on tide generating forces, equilibrium theory, dynamic theory, tide measurement, and tides in the earth and atmosphere are included in the publication.

Keywords: tides, hydrodynamics

58-02. Stevenson, R.E. and K.O. Emery (1958), "Marshlands at Newport Bay, California," Allan Hancock Foundation Publications, Occasional Papers No. 20, The University of Southern California Press, Los Angeles, California.

A thorough scientific investigation of the salt marshes in Newport Bay (Southern California) was completed just prior to major dredging and filling operations. Water and sediment characteristics were defined by measurement of temperature, salinity, pH, percent organic matter, and sediment grain size. The flora was sorted into six different communities. The communities are described in relationship to plant composition, vertical zonation, and soil type.

Keywords: Southern California, tidal marsh, water quality, soil, plant ecology

59-01 U.S. Department of Commerce (1959), "Future Development of the San Francisco Bay Area, 1960-2020," Prepared for the U.S. Army Engineer District, San Francisco Corps of Engineers, San Francisco, California.

The future development possibilities of the San Francisco Bay Area are explored in the report. Wetland acreages (and diked wetland acreages) are also provided.

Keywords: San Francisco Bay, inventory

62-01. Krone, R.B. (1962), "Flume Studies of the Transport of Sediment in Estuarial Shoaling Processes," Final Report, Contract No. DA-04-203 CIVENG-59-2, Prepared for San Francisco District, U.S. Army Corps of Engineers.

Flume studies were conducted to determine qualitative information about the transport and deposition processes of sediments in San Francisco Bay. Bay muds from Mare Island Strait are characterized.

Keywords: San Francisco Bay, sedimentation

64-01. Hall, G.A. (1964), "Breeding-Bird Censuses: Why and How," *Audubon Field Notes*, pp. 413-416, no. 18.

Breeding-bird censuses are important in determining population changes and the effects of habitat manipulation and human encroachment. Territorial males are counted and used as an indicator of breeding birds. If the species under consideration does not have territorial males, females should be counted. At least eight trips are required during the most productive nesting days to gain an accurate representation.

Keywords: birds, monitoring

65-01. Black, C.A. (ed.) (1965), *Methods of Soil Analysis, Part 1, Physical and Mineralogical Properties, Including Statistics of Measurement and Sampling*, American Society of Agronomy, Inc., Madison, Wisconsin.

The book is a treatise on the measurement of physical and mineralogical properties of soil. Items of interest for salt marsh soil monitoring include instructions on how to measure bulk density, compactibility, shear strength, bearing capacity, temperature, particle size distribution, and water content.

Keywords: soil

65-02. Black, C.A. (ed.) (1965), *Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties*, American Society of Agronomy, Inc., Madison, Wisconsin.

The book is a treatise on the measurement of chemical and microbiological properties of soil. Items of interest for salt marsh soil monitoring include instructions on how to determine concentrations of nitrogen, carbon, organic matter, and sulfur.

Keywords: chemistry and nutrients, soil

65-03. Fisler, G.F. (1965), "Adaptations and Speciation in Harvest Mice of the Marshes of San Francisco Bay," *University of California Publications in Zoology*, vol. 77, pp. 1-108.

A detailed discussion of the three forms of harvest mice (western harvest mouse, *Reithrodontomys megalotis*, and the salt marsh harvest mouse, *R. raviventris*, which has two subspecies, *R. r. raviventris* and *R. r. halicoetes*) found in San Francisco Bay is given in the article. Ecological distribution, physiological differences, reproduction, behavior, and isolating mechanisms are described for each species.

Keywords: San Francisco Bay, mammals, endangered species

65-04. Kolb, H. (1965), "The Audubon Winter Bird-Population Study," *Audubon Field Notes*, pp. 432-434, no. 19.

An Audubon accepted methodology for determining winter bird populations is described. Winter is defined as the period of time after fall migration has ended and before spring migration begins. Bird species are counted and their positions are recorded by an observer walking defined paths through the plot. At least seven trips during the winter are needed to compute a statistical average of the species populations.

Keywords: birds, monitoring

65-05. Pestrong, R. (1965), "The Development of Drainage Patterns on Tidal Marshes," *Geological Sciences, Stanford University Publications*, vol. 10, no. 2, pp. 1-87, School of Earth Sciences, Stanford University, Palo Alto, California.

Despite different environmental controls, drainage patterns on tidal marshes bear strong resemblances to terrestrial drainage systems. Drainage channels originate in the upper tidal flats during the ebb portion of the tidal cycle where they become incised into the mud.

Spartina is located at the lower marsh elevations and *Salicornia* is located in the higher marsh elevations. The highest channel velocities occur just before and after peak stage, with the maximum velocity occurring on the ebb flow portion of the tidal cycle. Measured rates of migration show a stronger correlation with channel geometry for the lower order (small) tributary segments than for the major trunk channels. Soil moisture content and soil size parameters appear to be the major factors controlling erodibility.

Keywords: San Francisco Bay, tidal marsh, geomorphology, plant ecology, sedimentation

65-06. U.S. Department of Commerce (1965), "Manual of Tide Observations," Publication 30-1, Coast and Geodetic Survey, U.S. Department of Commerce, Washington, D.C.

Instructions for observing and recording the rise and fall of the tide and for making the necessary reductions to determine the datum planes and the nonharmonic quantities, are contained in the publication.

Keywords: tides, hydrodynamics

66-01. Butler, G. and H.C.K. Ison (1966), "Corrosion and its Prevention in Waters," Reinhold Publishing Corporation, New York.

Cathodic protection of inland marine structures (metal) requires either a combination of sacrificial anode protection with corrosion resistant coatings, or active protection with electrical D.C. connections. If the footings of the structure are likely to be in sediments containing sulfate-reducing bacteria (marsh soils), then the potential of the structure should be depressed to a very low value in the range of 0.63 to 0.68 volts.

Keywords: corrosion, construction, structures, maintenance

66-02. Phleger, F.B. and J.S. Bradshaw (1966), "Sedimentary Environments in a Marine Marsh," *Science*, vol. 154, no. 3756, pp. 1551-1553.

Daily (24 hour) and annual recordings of soil salinity, temperature, dissolved oxygen, and pH are reported for a Mission Bay salt marsh.

Keywords: Southern California, salinity, soil, sedimentation

66-03. San Francisco Bay Conservation and Development Commission (1966), "Marshes and Mudflats," San Francisco Bay Conservation and Development Commission, San Francisco, California.

A brief discussion of San Francisco Bay mudflats and marshes, and their importance, is given in the pamphlet.

Keywords: San Francisco Bay, tidal marsh, ecology

66-04. Vogl, R.J. (1966), "Salt-Marsh Vegetation of Upper Newport Bay, California," *Ecology*, vol. 47, pp. 80-87.

The objective of the study was to characterize the relatively undisturbed vegetation of the Upper Newport Bay. The area was divided into zones according to plant species present and the tide heights. The frequency of occurrence and percent cover of all species were tabulated. The width and elevation of each zone, as well as the transition areas between the zones, were determined.

Keywords: Southern California, monitoring, tidal marsh, plant ecology

67-01. Griffiths, J. C. (1967), *Scientific Method in Analysis of Sediments*, McGraw Hill Book Company, New York.

Procedures are given for measuring sediment properties including grain size, shape, orientation and packing, mineral constituents and derived properties such as bulk density, porosity and permeability. Information on statistical methods of analysis and a brief discussion of the principles of experimental inquiry are also included in the book.

Keywords: soil, monitoring

67-02. MacDonald, K.B. (1967), "Molluscan Faunas of Pacific Coast Salt Marshes and Tidal Creeks," *The Veliger*, vol. 11, no. 4, pp. 399-405.

A survey of molluscan fauna in 11 Pacific Coast salt marshes and tidal creeks was completed to determine abundance, local variation in species populations and composition, diversity, and seasonality. The number of mollusc species increases southward along the Pacific Coast, but the differences are not due to latitude or tides. Local factors, such as sediment type, food supply, drainage, and vegetation, control the abundance. Tidal creeks usually contain more species than found on the marsh surface and species composition stays the same throughout the year.

Keywords: invertebrates, tidal marsh

68-01. Clancy, E.P. (1968), "The Tides: Pulse of the Earth," Doubleday & Company, Garden City, New York.

Sections on tide generating forces, equilibrium theory, dynamic theory, tide measurement, and tides in the earth and atmosphere are included in the publication.

Keywords: tides, hydrodynamics

69-01. MacDonald, K.B. (1969), "Quantitative Studies of Salt Marsh Mollusc Faunas from the North American Pacific Coast," *Ecological Monographs*, vol. 39, no. 1, pp. 33-60.

Mollusc species abundance and diversity are reported for salt marsh sloughs and plains for various sites along the Pacific Coast.

Keywords: invertebrates, tidal marsh

69-02. Mall, R.E. (1969), "Soil-Water-Salt Relationships of Waterfowl Food Plants in the Suisun Marsh of California," Wildlife Bulletin No. 1, California Department of Fish and Game, Sacramento, California.

Using plant food use and selection indices that were developed during the study, alkali bulrush (*Scirpus robustus*) was found to be the most commonly selected plant food for waterfowl, followed by brass buttons (*Cotula coronopifolia*). Salt grass (*Distichlas spicata*) and pickleweed (*Salicornia virginica*) were not selected by most duck species. The length of soil submergence was the most important factor in determining distribution and competitive ability, followed by soil salinity. As water salinities increase due to reduced freshwater flows into the Delta, alkali bulrush may be replaced by more salt tolerant species such as pickleweed, which could have deleterius effects on waterfowl.

Keywords: San Francisco Bay, birds, plant ecology, salinity, soil

69-03. Speth, J.W. (1969), "Status Report on the Coastal Wetlands of Southern California as of February 1, 1969," State of California, Department of Fish and Game.

The major coastal wetlands of Southern California are described in terms of marsh acreage, history of alterations, wildlife values, human use, development and preservation plans. Smaller and less studied wetlands are included in the report but presented in less detail. The information is a summary of the Department of Fish and Game's knowledge on Southern California coastal wetlands.

Keywords: Southern California, tidal marsh, planning

70-01. Barbour, M.G. and C.B. Davis (1970), "Salt Tolerance of Five California Salt Marsh Plants," *The American Midland Naturalist*, vol. 84, no. 1, pp. 262-265.

The salt tolerance of five species of California salt marsh plants (*Distichlis spicata*, *Frankenia grandifolia*, *Jaumea carnosa*, *Mesembryanthemum chilense* and *Salicornia virginica*) was tested in a controlled environment (greenhouse in Davis, Ca.). From the results of the four week study it was determined that all five plant species grew optimally in the lowest salinity (0.1 percent), while none of the species survived at the highest salinity (2.2 percent). It was concluded that all five species can be characterized as intolerant halophytes, which does not agree with previous findings. However, the plants tested were taken from a mildly brackish marsh and may not have been genetically suited to tolerate the higher salinities.

Keywords: Central California, plant ecology, tidal marsh, salinity, plant establishment

70-02. Fink, F.W. and W.K. Boyd (1970), *The Corrosion of Metals in Marine Environments*, Bayer & Company, Columbus, Ohio.

The concept of marine zone classification is introduced (i.e. splash zone, tidal zone, mud zone), and the impact of each micro-environment on metals is discussed. Most of the information contained in this book has been incorporated into the "Seawater Corrosion Handbook" (Schumacher 1979).

Keywords: corrosion, construction, structures, maintenance

70-03. Frey, H.W., R.F. Hein, and J.L. Spruill (1970), "Report on the Natural Resources of Upper Newport Bay and Recommendations Concerning the Bay's Development," Coastal Wetland Series No. 1, California Department of Fish and Game, Sacramento, California.

The Upper Newport Bay contains approximately one thousand acres of tidelands and salt marsh. It is one of the last relatively pristine estuaries in Southern California. The area is heavily used as a spawning and nursery ground for fish and a rest and feeding area for birds. The need for increased boating facilities and the rapid urbanization of Orange County is threatening the ecology of the bay. A comprehensive plan is proposed to protect part of the bay.

Keywords: Southern California, tidal marsh, ecology

70-04. Giguere, P.E. (1970), "The Natural Resources of Bolinas Lagoon: Their Status and Future," Coastal Wetland Series No. 3, California Department of Fish and Game, Sacramento, California.

Bolinas Lagoon is located in Marin County, approximately 15 miles north of San Francisco. The region's environs, natural resources, resource uses, and problems and use conflicts are characterized in the report.

Keywords: Central California, lagoon, ecology

70-05. Heath, J.P. (1970), "Estuarine Ecology: A Report on Santa Clara County Wetlands," Planning Policy Committee Baylands Subcommittee, Santa Clara County, California.

The functions and values of marshes and salt ponds are described in general. The baylands of Santa Clara County, including marshes and salt ponds, are described in greater detail. Recommendations are given to improve current conditions in various marshes to preserve the existing marshes.

Keywords: San Francisco Bay, ecology, planning

70-06. Speth, J.W., R. Fordice, R.F. Hein, and P.E. Giguere (1970), "The Natural Resources of Goleta Slough and Recommendations for Use and Development," Coastal Wetland Series No. 2, California Department of Fish and Game, Sacramento, California.

A general description of the history, ecology and resources of Goleta Slough is presented in the report. There are many developmental pressures on the slough. The immediate threat of habitat destruction through siltation is outlined in detail.

Keywords: Southern California, ecology, sedimentation

71-01. Delmonte, R.C. and J.W. Johnson (1971), "The Influence of Bed Material Size on the Tidal Prism-Area Relationship in a Tidal Inlet," Report No. HEL-24-8, University of California, Hydraulic Engineering Laboratory, Berkeley, California.

The effect of particle size on tidal prism-area was determined by using a simulated lagoon and ocean system connected by a twin jetty entrance. Measurements of channel cross section, tidal prism and surface elevations were made at four different ebb-flow rates. The experiments were performed with and without waves. Larger channel cross sections occurred with fine sand (D_{50}=0.3 mm) as compared to coarse sand (D_{50} = 0.52 mm). Channel throat area was reduced by wave action in the presence of the coarser sand.

Keywords: hydrodynamics, sedimentation

71-02. Gosner, K.L. (1971), *Guide to the Identification of Marine and Estuarine Invertebrates*, John Wiley & Sons, Inc., New York.

Description and classification information on marine invertebrates is provided in the book. The information that is presented is for Cape Hatteras to the Bay of Fundy on the East Coast and is only useful as a general reference for West Coast invertebrates.

Keywords: invertebrates, monitoring

71-03. Phleger, C.F. (1971), "Effect of Salinity on Growth of a Salt Marsh Grass," *Ecology*, vol. 52, pp. 908-911.

The salt tolerance of *Spartina foliosa* was tested on plants collected in Mission Bay, California. The plants were grown in nutrient solutions of known concentrations of seawater. The amount of growth decreased with increasing concentration of seawater. The most growth was found in plants grown in the 25 percent solution. Survival rates were highest in the 0 percent solution (freshwater). The higher survival rates in fresh and brackish water indicate that *Spartina* may have evolved from a freshwater plant to a halophyte to avoid competition. Various germination techniques were attempted but none succeeded. It is theorized that the seeds have become nonviable because it is easier for the plants to propagate from rhizomes.

Keywords: Southern California, plant ecology, salinity

72-01. Bradshaw, J. S. and P. J. Mudie (1972), "Some Aspects of Pollution in San Diego County Lagoons," California Cooperative Oceanic Fisheries Investigations Reports, vol. 16, pp. 84-94, State of California, Department of Fish and Game Research Committee, Sacramento, California.

Wastewater as a source of nutrients to several San Diego County lagoons is examined. It is concluded that orthophosphate is a relatively good indicator of nutrient enrichment, and that the shallow lagoons act as nutrient filters. All but a fraction of the original nutrient load is prevented from reaching the nearshore waters.

Keywords: Southern California, lagoon, wastewater treatment, chemistry and nutrients, water quality, salinity, monitoring

72-02. Browning, B.M. (1972), "The Natural Resources of Elkhorn Slough," Coastal Wetland Series No. 4, California Department of Fish and Game, Sacramento, California.

Elkhorn Slough is located in Monterey County, between San Francisco Bay and Morro Bay. The region's environs, natural resources, resource uses and problems are characterized.

Keywords: Central California, tidal marsh, ecology

72-03. Cameron, G.N. (1972), "Analysis of Insect Trophic Diversity in Two Salt Marsh Communities," *Ecology*, vol. 53, pp. 58-73.

Trophic relationships of the insect component of two intertidal salt marsh communities dominated by *Salicornia pacifica* and *Spartina foliosa*, respectively, were analyzed in the study. In both communities, herbivore diversity was highest during the spring months (when plant growth rates are high), while saprovore diversity was highest during midwinter (peak time of plant decay). Predator diversity responded to both herbivore and saprovore diversity.

Keywords: San Francisco Bay, insects

72-04. Miller, D.J. and R.N. Lea (1972), "Guide to the Coastal Marine Fishes of California," California Fish Bulletin #157, California Department of Fish and Game, Sacramento, California.

Identification information on all shallow-water marine fishes within California waters is included in the publication. A total of 554 species are described by geographic range, size, depth range, color, and biological characteristics. Sketches of the fish are also included. Organization of the text is provided in a manner which allows identification of species quickly by a series of observations.

Keywords: fish, monitoring

72-05. Pestrong, R. (1972), "San Francisco Bay Tidelands," *California Geology*, vol. 25, pp. 27-40.

A detailed description of San Francisco Bay and its tidal marshes is provided in the article. The focus of the paper is on marsh development.

Keywords: San Francisco Bay, plant ecology, hydrodynamics, sedimentation

72-06. Ritter, J.R. (1972), "Cyclic Sedimentation in Agua Hedionda Lagoon, Southern California," *Journal Waterways, Harbors and Coastal Engineering*, vol. 98, pp. 597-602, American Society of Civil Engineers, New York.

Monthly sedimentation measurements were made in Agua Hedionda Lagoon for two years. A six month cycle in the rate of sediment accumulation was determined. High rates occurred in March and September. Low rates occurred in May, June and December coinciding with times of high tide ranges.

Keywords: Southern California, lagoon, sedimentation

72-07. Woodhouse, W.W., Jr., E.D. Seneca, and S.W. Broome (1972), "Marsh Building with Dredge Spoil in North Carolina," Agricultural Experiment Station, North Carolina State University at Raleigh, Bulletin 445, Raleigh, North Carolina.

The steps to establish *Spartina alterniflora* on dredge spoil are described in detail. The successes and failures of the plantings are discussed as are suggested methods to obtain optimum plant growth.

Keywords: dredge spoil, tidal marsh, plant establishment

73-01. Aitken, F.W., R.W. Cook, G. Tchobanoglous, K.F. Kline, and B.K. Williams (1973), "Identification of the Transition Area in the Suisun Bay Marsh with Specific Reference to the Smith Ranch," Prepared for the Monroe Company.

Chapters covering background information on Suisun Marsh and marshes in general, the transition area in the Suisun Marsh, identification of the transition area on the Smith Ranch, and transition area implications are included in the report. Maps of the Smith Ranch and soil survey information are also contained in the report.

Keywords: San Francisco Bay, plant ecology, soil

73-02. Browning, B.M. and J.W. Speth (1973), "The Natural Resources of San Diego Bay, Their Status and Future," Coastal Wetland Series No. 5, California Department of Fish and Game, Sacramento, California.

Only 10 percent of the original 2400 acres of wetlands in the San Diego Bay remain after extensive dredging and filling were undertaken in the 1940's. Discharge of municipal wastewater was terminated in 1963. Water quality is improving, but the bay has been quarantined and the shellfish have been determined to be unfit for human consumption. Pollutants from shipyards, agricultural runoff and urban runoff are adsorbing to sediment particles. Approximately 75 percent of the watershed is controlled and as a result, freshwater inflow to the bay is very small. Siltation is not considered to be a problem, as dams capture most of the sediment.

Keywords: Southern California, tidal marsh, ecology, water quality, inventory

73-03. Day, D.A. (1973), *Construction Equipment Guide*, John Wiley and Sons, New York.

Draglines and clamshells are evaluated and found to be more suitable for excavating submerged soil as compared to other equipment. Different types of clamshells and draglines are also compared for specific applications. This general guide and equipment dictionary provides some calculation on the application of tracks versus rubber tires in various soil conditions. There is little mention of direct application of equipment under saturated soil conditions.

Keywords: construction equipment, construction

73-04. Hull, W.V. and C.I. Thurlow (1973), "Tidal Datums and Mapping Tidal Boundaries," Prepared for the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Rockville, Maryland.

Tidal datums are determined points of reference for measuring water surface elevations. Mean sea level (MSL) is the 19 year average hourly water level, and the National Geodetic Vertical Datum (NGVD) is the MSL for 1929. Benchmarks are established on shore for the determined tidal datum. Benchmarks are used to map tidal boundaries or to determine tidal elevations. Interpolated water levels can be obtained if a tidal datum exists at two locations within the general area. Photogrammetric procedures can also be used to map tidal boundaries. Aerial black and white infrared photos are taken during the tide stage of interest.

Keywords: tides, hydrodynamics, monitoring

73-05. Kershaw, K.A. (1973), *Quantitative and Dynamic Plant Ecology*, Edward Arnold Limited, London, England.

The book contains descriptions of measurement techniques for classification and ordination of vegetation samples. Methods for the determination of horizontal distribution, abundance, and frequency are explained in practical terms. Information is also included on choice of transect size and position.

Keywords: plant ecology, monitoring

73-06. Monroe, G.W. (1973), "The Natural Resources of Humboldt Bay," Coastal Wetland Series No. 6, California Department of Fish and Game, Sacramento, California.

Humboldt Bay is the only commercially important harbor between San Francisco Bay and Coos Bay, Oregon. The wildlife resources of Humboldt Bay are second in California only to the San Francisco Bay in number and variety of species. Approximately six hundred acres of salt marsh remain from an estimated original amount of seven thousand acres. Filling of the marsh occurred to create commercial and industrial sites. Reclamation of the marshlands by levee construction was undertaken to produce pastureland. Discharge of partially treated sewage and industrial wastewater, along with increased sedimentation due to upstream logging, are threatening the remaining resource values.

Keywords: Northern California, tidal marsh, ecology, water quality, sedimentation, inventory

73-07. Teal, J. M. and I. Valiela (1973), "The Living Filter," *Oceanus*, vol. 17, pp. 7-10.

Qualitative results from an experiment involving the application of sterilized sewage sludge to a salt marsh are presented in the article. Plant growth responded positively to sludge application. Only fiddler crab populations were negatively impacted, declining by 50 percent. Nitrogen removal potential for the Sippewissett marsh was estimated to be at least 110 g of nitrogen per square meter per year.

Keywords: tidal marsh, ecology, water quality, plant establishment, wastewater treatment

73-08. U.S. Army Corps of Engineers, San Francisco District (1973), "Environmental Impact Statement: Operation and Maintenance of Humboldt Harbor and Bay, Jetties and Dredging, Humboldt County, California," U.S. Army Engineer District, San Francisco, California.

Issues that are pertinent to the rebuilding of heavily damaged jetties at the harbor mouth, and dredging requirements in the Bay, are addressed specifically in the report. The data compiled in the environmental impact statement does not deal with salt marshes.

Keywords: Northern California

74-01. Brady, N.C. (1974), *The Nature and Properties of Soils*, 8th Edition, MacMillan Publishing Co., Inc., New York.

The book includes information on the physical and chemical properties of soil. The importance of soil characteristics in relation to plant growth is emphasized.

Keywords: chemistry and nutrients, soil

74-02. California Department of Fish and Game (1974), "Bolsa Chica Marsh Re-Establishment Project: Volume 1," California Department of Fish and Game, Sacramento, California.

The history and 1974 conditions of Bolsa Chica Marsh are described in the report. The marsh re-establishment project and its alternatives, construction specifications, and cost estimates are also discussed.

Keywords: Southern California, marsh restoration, planning, construction

74-03. California Department of Fish and Game (1974), "Bolsa Chica Marsh Re-Establishment Project, Volume II, Final Environmental Impact Report," California Department of Fish and Game, Sacramento, California.

The salt marsh of Bolsa Chica Bay has been isolated from tidal flow since tide gates were installed in the 1890's. On-site oil and gas extraction began in the 1930's and has continued to present. The goals of the reestablishment project are to provide fish nurseries and forage, provide habitat for endangered species, and develop science and educational use of the marsh. Levees will be constructed to contain 150 acres of tidal waters. Tide gates will be used to regulate flows until the ecosystem stabilizes. Islands will be constructed to provide additional wildlife habitat and Least Tern nesting sites. The increase in the tidal prism is expected to place a strain on existing bridge supports and scour channel bottoms. Protective abutments will be placed on the bridge supports and the channel bottoms will be lined with rock. Flooding of the marsh will be done in stages to minimize erosion. Some areas will be sealed off from flooding to prevent leaching of oil and lowering of oxygen levels.

Keywords: Southern California, tidal marsh, marsh restoration

74-04. Dukes, J.C., R.C. Axtell, and K.L. Knight (1974), "Additional Studies on the Effects of Salt Marsh Impoundments on Mosquito Populations," Report No. 102, Water Resources Research Institute of the University of North Carolina, North Carolina State University, Raleigh, North Carolina.

The purpose of the study was to compare a natural marsh, an impounded marsh and a partially impounded marsh. The natural marsh and the partially impounded marsh did not support mosquito populations (natural marsh was inundated by tides too often) and the impounded marsh had very low mosquito larvae numbers. Due to the test area conditions, nothing could be determined regarding the effectiveness of impoundments to inhibit mosquito populations.

Keywords: insects, tidal marsh, maintenance, mosquito control

74-05. Gerdes, G.L., E.R.J. Primbs, and B.M. Browning (1974), "The Natural Resources of Morro Bay: Their status and Future," Coastal Wetland Series No. 8, California Department of Fish and Game, Sacramento, California.

Morro Bay is located in San Luis Obispo County and is approximately half-way between Los Angeles Harbor and San Francisco Bay. The region's environs, natural resources, resource uses, and problems and use conflicts are characterized in the report.

Keywords: Central California, tidal marsh, ecology, inventory

74-06. Isaacs, J. D., P. J. Mudie, and J. R. Moriarty (1974), "Studies of Recent History of California Coastal Lagoons," Sea Grant Publication No. 37, California Sea Grant College, University of California, San Diego.

A multidisciplinary approach interpreting recent history of California coastal lagoons reveals that shell gathering cultures persisted around the lagoons (at least intermittently) for nine millenia, subjecting the lagoons to the most intensive levels of use applied to any marine waters.

Keywords: lagoon, ecology

74-07. Kadlec, J.A. and W.A. Wentz (1974), "State-of-the-Art Survey and Evaluation of Marsh Plant Establishment Techniques: Induced and Natural; Volume 1: Report of Research," Report D-74-9, Dredged Material Research Program, Environmental Effects Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Other factors being equal, local species are more likely to succeed than introduced ones. Site peculiar characteristics, such as tides, salinity, drainage, climatic factors, and light penetration, are quite important in determining establishment success. As far as propagation procedures are concerned, seeding is usually least expensive, but transplants have the highest rate of success. It can be expected that the basic problems to be encountered in marsh establishment will be physically unsuitable substrates, nutrient deficiencies, contaminated

sediments, excessive wind or current action, excessive turbidity, unfavorable patterns of water level fluctuations, and unfavorable water depths.

Keywords: tidal marsh, freshwater marsh, marsh restoration, plant establishment, dredging

74-08. Lasalle, R.N. and K.L. Knight (1974), "Effects of Salt Marsh Impoundments on Mosquito Populations," Report No. 92, Water Resources Institute of the University of North Carolina, North Carolina State University, Raleigh, North Carolina.

Salt marsh impoundments are effective at eliminating larval populations of important pest species on the East Coast. Salt marsh impoundments are used to close off marsh areas and raise the water level to inhibit mosquito populations. The raising of the water level kills off almost all the marsh plant species, which changes the character of the marsh and its surrounding areas. Salt marsh impoundments should only be used when all other mosquito population control measures have proven inadequate.

Keywords: insects, tidal marsh, maintenance, mosquito control

74-09. Monroe, G.M. and F. Reynolds (1974), "Natural Resources of the Eel River Delta," Coastal Wetland Series No. 9, California Department of Fish and Game, Sacramento, California.

The Eel River Delta consists of the flood plain of the Eel River from the ocean to approximately ten miles upriver. The delta has good water quality and wildlife habitat. The area is heavily used by anglers and waterfowl hunters. Fish catches are on the decline mainly due to increased siltation. The soils of the watershed are highly erodible and disturbances from logging, road building and livestock grazing have accelerated the erosion process. Flood control proposals are being considered which include building upstream dams and channelizing the lower reaches of the river.

Keywords: Northern California, ecology, sedimentation, inventory

74-10. Mudie, P.J., B.M. Browning, and J.W. Speth (1974), "The Natural Resources of Los Penasquitos Lagoon and Recommendations for Use and Development," Coastal Wetland Series No. 7, California Department of Fish and Game, Sacramento, California.

The natural resources and history of Los Penasquitos Lagoon are described. Possible solutions to the problem of inadequate tidal flushing are given; including removal of a cobble sill that has accumulated in the inlet, jetty construction, and fluidization of sediment.

Keywords: Southern California, ecology, lagoon, hydrodynamics, sedimentation, inventory

74-11. Phillips, R.C. (1974), "Transplantation of Seagrasses, with Special Emphasis on Eelgrass (*Zostera marina* L.)," *Aquaculture*, vol. 44, pp. 161-176.

Several different techniques used to transplant eelgrass are described in the article. Varietal distinctions based on leaf dimensions are invalid. Local physiological race distinction is possible based on temperature. Light intensity influences the lower limit of distribution.

Keywords: sea grasses, plant establishment

74-12. San Francisco Bay Conservation and Development Commission (1974), "Bay Issues: Options for the Future of San Francisco Bay," San Francisco Bay Conservation and Development Commission, San Francisco, California.

The report consists of a general discussion of San Francisco Bay issues. Current status of BCDC is discussed and questions are posed about its future. Two issues covered in some detail are salt ponds and the Suisun Marsh area.

Keywords: San Francisco Bay, ecology, planning

74-13. Small, A. (1974), *The Birds of California*, Winchester Press, New York.

The book contains an annotated list of all the bird species that are found in California. Descriptions include seasonal status, habitat, and range in California.

Keywords: birds, monitoring

74-14. California State Water Resources Control Board (1974), "Water Quality Control Policy for the Enclosed Bays and Estuaries of California," State of California, The Resources Agency, Sacramento, California.

Discharge prohibitions and the specific requirements for allowable discharges are detailed in the policy. The disposal of dredge spoils must meet federal criteria and must be certified by the State Water Resources Control Board or the Regional Water Quality Control Board. All dischargers must comply with the Porter-Cologne Water Quality Control Act. The State Board permits the Regional Boards to adopt stricter regulations and gives them the responsibility for enforcement.

Keywords: dredge spoil, water quality, regulations

74-15. Swanson, R.L. (1974), "Variability of Tidal Datums and Accuracy in Determining Datums from Short Series of Observations," NOAA Technical Report NOS 64, National Ocean Survey, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Rockville, Maryland.

Results of investigations involving the accuracy of tidal datums determined from short (less than 19 years) series of observations are included in the publication. Estimates of the expected accuracies possible using 1, 3, 6, or 12 months of observations are also given.

Keywords: tides, hydrodynamics

74-16. U.S. Bureau of Sport Fisheries and California Department of Fish and Game (1974), "Acquisition Priorities for the Coastal Wetlands of California," A Joint Report of United States Bureau of Sport Fisheries and State of California Department of Fish and Game, Sacramento, California.

The 1968 California Wetlands Inventory, along with additional on-site inspections, was conducted to determine twenty-five priority wetlands. The status of priority for acquisition was determined by comparing abundance and diversity of fish and wildlife, the types of habitats present and the use by different species, the impending threats to the area, land ownership and size. The list of twenty-five was narrowed down to ten top priority areas. Upper Newport Bay, South San Diego Bay and the Tijuana Estuary were placed at the head of the list. Recommendations for preservation including purchase and potential restoration projects are given for the top ten areas.

Keywords: ecology, planning, inventory

74-17. Whelan, T. (1974), "Methane, Carbon Dioxide and Dissolved Sulfate from Interstitial Water of Coastal Marsh Sediments," *Estuarine and Coastal Marine Science*, vol. 2, pp. 407-415.

The depth distributions of methane, carbon dioxide, and dissolved sulfate in interstitial waters are reported for three areas in Louisiana. The highest concentration of methane was found at a marsh which had low salinities (5-10 ppt) compared to the others (22-25 ppt). In general, where the dissolved sulfate concentration was low, the methane concentration was high and vice-versa. Competitive chemical reactions were thought to cause the methane-sulfate concentration relationship. Relatively small vertical gradients of dissolved methane and total carbon dioxide, the low hydrostatic head above the sediment column, and the high degree of unconsolidation are indications that gas is migrating upward through the sediment column.

Keywords: chemistry and nutrients, water quality, soil

74-18. Woodhouse, W.W., Jr., E.D. Seneca, and S.W. Broome (1974), "Propagation of *Spartina alterniflora* for Substrate Stabilization and Salt Marsh Development," Technical Memorandum No. 46, U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Virginia.

Transplanting and seeding techniques for establishing *Spartina alterniflora* on dredge spoils are described. The optimum planting and seeding methods, spacings, elevations and times of year are described in detail. Also included in the report are methods to obtain transplants and seeds. Studies to determine the ability of *Spartina alterniflora* to stabilize substrates were inconclusive because of an inability to develop satisfactory evaluation procedures. Fertilization with nitrogen and phosphorous increased plant and seed production in many marshes.

Keywords: dredge spoil, marsh restoration, plant establishment

75-01. Allen, L.G. and H. Horn (1975), "Abundance, Diversity, and Seasonality of Fishes in Colorado Lagoon, Alamitos Bay, California," *Estuarine and Coastal Marine Science*, vol. 3, pp. 371-380.

Resident adult and juvenile fish were collected in a semi-enclosed bay in Southern California. Northern anchovy, topsmelt, slough anchovy, and shiner surfperch comprised 99 percent of the catch.

Keywords: Southern California, fish

75-02. Broome, S.W. (1975), "Stabilizing Dredge Spoil by Creating New Salt Marshes with *Spartina alterniflora*," In *Proceedings of the 15th Annual Meeting of the Soil Science Society of North Carolina*, Raleigh, North Carolina.

The results of introducing *Spartina alterniflora* to saltwater marshes created on dredge spoil along the North Carolina coast are reported. Success was achieved using both seeding and transplanting methods. Mechanization was utilized in harvesting and threshing seeds and in transplanting seedlings. Collection of seedlings was the main bottleneck in the large scale mechanical transplanting process. Seeds were successfully stored in seawater at 35° F for 4 months.

Keywords: dredge spoil, plant establishment, tidal marsh, marsh restoration

75-03. de la Cruz, A.A. (1975), "Proximate Nutritive Value Changes During Decomposition of Salt Marsh Plants," *Hydrobiologia*, vol. 47, no. 3-4, pp. 475-480.

The caloric and nutritive value of three salt marsh plant species were measured from collections made in a Mississippi marsh. The measurements were made from live, dead and decomposing plants (after six months of decomposition) and particulate detritus (after twelve months of decomposition). Plants that fell into the creeks decomposed faster than the ones that remained on the marsh. The caloric value of the plants in different stages of decomposition changed very little. It is theorized that calories are retained because microorganisms invade the dead plants. The amount of protein present in the plants decreased with age, but increased sharply between the dead and detritus stages. Fiber and carbohydrates decreased with decomposition; leading to a conclusion that detritus has more nutritive value than live plants, because there is less fiber and cellulose to digest.

Keywords: tidal marsh, chemistry and nutrients, water quality

75-04. Garbisch, E.W., Jr., P.B. Woller, and R.J. McCallum (1975), "Salt Marsh Establishment and Development," Technical Memorandum No. 52, U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Virginia.

The establishment of seedling transplants of *Spartina alterniflora* in the intertidal zone of Chesapeake Bay, for the purpose of shoreline erosion abatement, is discussed. The establishment of *S. alterniflora* was limited by wave and suspended coarse sediment stresses. Mortalities in high-stress intertidal areas increased with decreasing elevation. *Spartina alterniflora* production increased with periodic fertilization in sandy areas. Macrobenthic invertebrates invaded and colonized the dredged material area slowly, but the area eventually had significantly more organisms than a nearby natural marsh. Macrobenthos populations increased with decreasing elevation from HW to 0.15 m below MLW (lowest monitoring point). *Spartina patens*, *S. cynosuroides*, *Distichlis spicata* and *Ammophila breviligulata*

were transplanted in the supratidal (above MHW) zone and all species grew well with minimum plant mortality.

Keywords: marsh restoration, soil, monitoring, plant establishment, erosion control

75-05. Garbisch, E.W., P.B. Woller, W.J. Bostian, and R.J. McCallum (1975), "Biotic Techniques for Shore Stabilization," In L.E. Cronin (ed.), *Estuarine Research, Vol. II, Geology and Engineering*, Academic Press, Inc., New York.

The survival rates for various plant species subjected to different environmental pressures are presented and discussed. The research topics included planting methods, fertilization, tidal inundation and wave stresses. Shore stabilization was achieved when revegetation was successful. Benthic invertebrates repopulated the areas within one year of planting.

Keywords: erosion control, plant establishment

75-06. Huston, J. (1975), "Techniques for Reducing Turbidity with Present Dredging Procedures and Operations," In *Proceedings of the Seventh Dredging Seminar*, Texas A&M University, Sea Grant College, College Station, Texas.

Turbidity reduction when dredging is best accomplished by following proper dredging procedures, which also tend to be the most economically efficient. Some proper dredging techniques are described briefly, The techniques include choosing appropriate equipment and dredging when turbidity levels are naturally high. Better training of dredge operators and inspectors is also recommended.

Keywords: dredging

75-07. Johnson, L.E. and W.V. McGuinness, Jr. (1975), "Guidelines for Material Placement in Marsh Creation," U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

Guidelines for creating new marshes using dredged material under a variety of conditions are presented in the report. The emphasis of the report is on creating areas where marshes may develop using dredge spoil. Marsh design and construction details are not considered.

Keywords: soil, marsh restoration, construction, dredging, construction equipment, dredge spoil

75-08. Laque, F.L. (1975), *Marine Corrosion: Causes and Prevention*, John Wiley & Sons, New York.

Information on corrosion in marine environments is provided in this book. Problems that have been experienced in the past are demonstrated with many examples and pictures.

Keywords: corrosion, construction, structures, maintenance

75-09. Monroe, G.M., B.J. Mapes, and P.L. McLaughlin (1975), "Natural Resources of Lake Earl and the Smith River Delta," Coastal Wetland Series No. 10, California Department of Fish and Game, Sacramento, California.

The Smith River Delta consists of approximately four miles of the Smith River that is subject to tidal action. The delta has extensive areas of mudflats and intertidal channels, but only isolated strands of salt marsh. Lake Earl is similar to the coastal lagoons of Southern California. A sand barrier periodically builds up and cuts off tidal flow. The barrier is mechanically removed to provide flood control. Lake Earl has much larger areas of salt marsh than the Smith River. Both areas have excellent water quality and are heavily utilized by wildlife. Logging in the Smith River watershed is threatening fisheries through increased siltation.

Keywords: Northern California, tidal marsh, freshwater marsh, lagoon, ecology, inventory

75-10. Mulhern, T.D. (ed.) (1975), *A Training Manual for California Mosquito Control Agencies*, CMCA Press, Visalia, California.

The duties and responsibilities of mosquito abatement personnel in California are described in the manual. Of special interest is a section which deals specifically with the requirements of salt marshes. Salt marshes with good circulation patterns need little or no abatement modifications. Salt marshes with poor circulation may require an extensive network of ditches to improve circulation and drain ponded water. A list of important species is also provided and described along with a county key, identifying the range of different species.

Keywords: insects, hydrodynamics, planning, monitoring, mosquito control

75-11. Page, G. and L. Stenzel (1975), "Aspects of the Ecology of Shorebirds on Bolinas Lagoon," Prepared for the Department of Parks and Recreation, County of Marin, California.

Information on the spatial and temporal distribution of shorebirds and basic aspects of shorebird biology on Bolinas Lagoon is provided in the report.

Keywords: Central California, birds

75-12. Seneca, E.D., W.W. Woodhouse, Jr., and S.W. Broome (1975), "Salt-Water Marsh Creation," In L.E. Cronin (ed.), *Estuarine Research, Vol II, Geology and Engineering*, Academic Press, Inc., New York.

Methods of transplant storage and propagation for revegetation were analyzed. Productivity was high for *Spartina alterniflora* even after ten weeks of storage in the intertidal zone. Seeding versus transplanting was compared. Seeding produced seventy percent of the yield obtained through transplantation.

Keywords: marsh restoration, plant establishment

75-13. Standing, J., B.M. Browning, and J.W. Speth (1975), "The Natural Resources of Bodega Harbor," Coastal Wetland Series No. 11, California Department of Fish and Game, Sacramento, California.

Bodega Harbor is a coastal embayment located in southwestern Sonoma County, about 60 miles north of San Francisco Bay. The region's environs, natural resources, resource uses, and problems and conflicts are characterized in the report.

Keywords: Central California, tidal marsh, freshwater marsh, ecology, inventory

75-14. Thompson, W.C. (1975), "Hydrographic Analysis of Palo Alto Marsh Island, South San Francisco Bay: Preliminary Report," Unpublished Report for the State Lands Division, Sacramento, California.

The following aspects related to the hydrography of the island are covered in the analysis: hypsography (distribution of area with elevation), physiography, elevation of the island with respect to the vertical datum planes, marsh vegetation distribution, and comparison with Bird Island. There appears to be no distinct zones of vegetation on the island. The vegetation is well mixed and includes primarily cordgrass, pickleweed, and saltgrass. Palo Alto Marsh Island has a lower marsh plain elevation compared to Bird Island, and is most likely the result of greater land subsidence in the area.

Keywords: San Francisco Bay, tidal marsh, hydrodynamics, plant ecology

75-15. Vanoni, V.A. (ed.) (1975), *Sedimentation Engineering*, American Society of Civil Engineers, New York.

The manual includes information on all facets of sediment engineering, including sampling, lab tests, and modeling.

Keywords: sedimentation, soil, geomorphology, erosion control, monitoring

76-01. Bradshaw, J.S. (1976), "The Natural Resources of Agua Hedionda Lagoon," Coastal Wetland Series No. 16, California Department of Fish and Game, Sacramento, California.

The Agua Hedionda Lagoon is made up of three interconnected sections. The outer area is used as a cooling water supply for a power plant. The inner and middle sections are used for recreational purposes. An underwater channel system supplies ocean water to each area. The lagoon system has a large tidal prism and good flushing. Most of the salt marsh has been lost to dredging and filling of the shoreline. Shoaling of sand just inside the entrances to each area is becoming a problem. Maintenance dredging will probably have be performed periodically to ensure continued flushing.

Keywords: Southern California, lagoon, ecology, inventory

76-02. California State Lands Commission (1976), "A Report on the Use, Development, and Administration of Granted Tidelands and Submerged Lands," California State Lands Commission, Sacramento, California.

The State of California has the power to grant "in trust" state owned tide and submerged lands to local public jurisdiction. The granted lands are to be used to benefit the public. Currently (1976) the State Lands Commission does not communicate well with the local governments and has been placed in a position of reviewing accomplished fact instead of reviewing land use and development plans, which has resulted in poor management practices. Several recommendations are made to improve the Commission's regulatory and policing power over their granted lands.

Keywords: permitting

76-03. Cameron, G.N. (1976), "Do Tides Affect Coastal Insect Communities?," *The American Midland Naturalist*, vol. 95, no. 2, pp. 279-287.

The number of insect species and the number of individuals per species were counted during a one year study in a salt marsh on San Pablo Bay. Vegetation was cut at predetermined strata and collected weekly. Insects were extracted from the vegetation and counted. There was no significant difference in the number of individuals found before, during and after inundation. No upward movement of insects along the plants to avoid submergence, and no change in taxonomic structure or trophic arrangement after inundation was observed. Tidal inundation was determined to have virtually no effect on salt marsh insects. The populations are controlled by biological rather than physical factors.

Keywords: San Francisco Bay, insects, tidal marsh

76-04. Cammen, L.M., E.D. Seneca, and B.J. Copeland (1976), "Animal Colonization of Man-Initiated Salt Marshes on Dredge Spoil," Technical Paper No. 76-7, U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Virginia.

Macrofauna comparisons were made between natural marshes, planted dredge spoil marshes and areas of bare dredge spoil at two locations in North Carolina. The planted dredge spoil marshes were both about two years old. At one location the fauna of the man-made marsh was similar in both species quantity and diversity to the nearby natural marsh. The man-made marsh was similar to the natural marsh in both sediment type and elevation. At the other location the man-made marsh was quite different than the natural marsh, but in this case the sediments and elevations were also quite different. Estimates to determine the time it would take for the spoil marshes to achieve the same organic content as the natural marshes revealed that one of the study marshes will achieve similarity in about 4 years, while the other marsh will take as long as 25 years.

Keywords: dredge spoil, invertebrates, soil, monitoring, marsh restoration

76-05. Chalmers, A.G., E.B. Haines, and B.F. Sherr (1976), "Capacity of a *Spartina* Salt Marsh to Assimilate Nitrogen from Secondarily Treated Sewage," Report No. ERC 0776, Georgia Environmental Resources Center, Atlanta, Georgia.

Sewage sludge was applied to a *Spartina* salt marsh in Georgia. Sludge fertilization of the marsh resulted in increased plant growth, increased total nitrogen content in the surface soils, and increased concentrations of exchangeable ammonium in the top 0.3 m of the soil. However, the sludge appeared to inhibit the activity of denitrifying bacteria in the marsh soils,

which differed from the findings of other studies. It was estimated that about 50 percent of the applied sludge was washed into the estuary by tidal action, which suggests that direct application onto marshes is not an efficient method for sludge disposal for the given region.

Keywords: water quality, chemistry and nutrients, wastewater treatment

76-06. Coastal Zone Resources Corporation (1976), "Identification of Relevant Criteria and Survey of Potential Application Sites for Artificial Habitat Creation, Relevant Criteria for Marsh-Island Site Selection and Their Application," Volume I, Contract Report D-76-2, U.S. Army Corps of Engineers Waterways Experiment Station, Environmental Effects Laboratory.

A process for marsh creation site consideration and selection is detailed in Volume I. An overview of environmental requirements, properties of dredged materials, sediment transport, and existing topographic relationships is included to properly consider advantages and disadvantages of potential sites. Different options for habitat construction, and the elements of an effective site reconnaissance program are identified.

Keywords: tidal marsh, marsh restoration, construction, planning

76-07. Coastal Zone Resources Corporation (1976), "Identification of Relevant Criteria and Survey of Potential Application Sites for Artificial Habitat Creation, Survey of Potential Application Situations and Selection and Description of Optimum Project Areas," Volume II, Contract Report D-76-2, U.S. Army Corps of Engineers Waterways Experiment Station, Environmental Effects Laboratory.

The selection process outlined in Volume I was tested to narrow down a list of fifty different marsh creation sites across the United States. The fifty sites were originally chosen on the basis of amount of dredge spoil generated for disposal. The Petaluma River area was selected as an optimum site in California. A large amount of dredge spoil is produced from maintenance dredging and the creation of marsh habitat would significantly increase wildlife values, including the establishment of fish nursery grounds and endangered species habitat.

Keywords: San Francisco Bay, tidal marsh, marsh restoration, planning, dredge spoil

76-08. Harrison, J.G. (1976), "Wetlands for Waterfowl," Council of Europe's Information Centre for Nature Conservation, Strasbourg, France.

A man-made wetland was created at Sevenoaks in Kent, England. The marsh was constructed from a former gravel pit. After twenty years of voluntary work by several individuals, the area has developed into a productive freshwater wetland. General guidelines are given for the construction of physical features such as banks, spits, islands and shallows and for the selection of plants for food, cover, nesting and landscaping.

Keywords: birds, freshwater marsh, marsh restoration, construction

76-09. MacDonald, K.B. (1976), "The Natural Resources of Carpinteria Marsh, Their Status and Future," Coastal Wetland Series No. 13, California Department of Fish and Game, Sacramento, California.

The natural resources of Carpinteria Marsh are described in the report, as well as the history of activities within and around the marsh. Proposals to prevent further deterioration of the ecosystem are suggested.

Keywords: Southern California, ecology, sedimentation, inventory

76-10. MacDonald, K.B. (1976), "The Natural Resources of Mugu Lagoon," Coastal Wetland Series No. 17, California Department of Fish and Game, Sacramento, California.

The natural resources and history of Mugu Lagoon are described in the report. Management problems and future development are emphasized. The lagoon is located within a U.S. Navy base and the protection of the base has left it relatively undisturbed. Concern is raised over potential water quality and sedimentation problems resulting from upstream discharges and development.

Keywords: Southern California, ecology, sedimentation, inventory

76-11. Mahall, B.E. and R.B. Park (1976), "The Ecotone Between *Spartina foliosa* Trin. and *Salicornia virginica* L. in Salt Marshes of Northern San Francisco Bay. I. Biomass and Production," *Journal of Ecology*, vol. 64, pp. 421-433.

In San Pablo Bay nearly monospecific communities of *Spartina foliosa* are located in the mid-littoral zone (sea level to MHW), while nearly monospecific communities of *Salicornia virginica* are located in the upper-littoral zone (MHW to highest tides). The total standing crop and production of both species was found to decrease to a minimum at the middle of the ecotone. It was concluded that zonation appears to be dependent on physical and physiological responses rather than on interspecific competitive effects.

Keywords: San Francisco Bay, tidal marsh, plant ecology, plant establishment

76-12. Mahall, B.E. and R.B. Park (1976), "The Ecotone Between *Spartina foliosa* Trin. and *Salicornia virginica* L. in Salt Marshes of Northern San Francisco Bay. II. Soil Water and Salinity," *Journal of Ecology*, vol. 64, pp. 793-809.

During the spring and summer growing season the apparent salinity in the upper-littoral *Salicornia* zone was greater than that in the mid-littoral *Spartina* zone. The differences were insignificant during the winter rainy season when both species are essentially dormant. *Salicornia* was found to occupy a habitat with considerably higher soil salinity than that of *Spartina* during the growing season. Lab experiments were also conducted and it was found that *Spartina foliosa* plants are less tolerant of rapid salinity changes than *Salicornia virginica* plants. *Salicornia* plant growth was much less inhibited in higher root medium salinities than *Spartina* plant growth. It was concluded that the higher apparent salinities in the salt marsh *Salicornia* zones during the growing season appear to be sufficient to exclude *Spartina*.

Keywords: San Francisco Bay, tidal marsh, salinity, plant establishment, plant ecology

76-13. Mahall, B.E. and R.B. Park (1976), "The Ecotone Between *Spartina foliosa* Trin. and *Salicornia virginica* L. in Salt Marshes of Northern San Francisco Bay. III. Soil Aeration and Tidal Immersion," *Journal of Ecology*, vol. 64, pp. 811-819.

Soil aeration and tidal immersion were checked to determine if either affected the exclusion of *Salicornia* from the *Spartina* zone. It was found that soil aeration was not the cause of *Salicornia* exclusion. In laboratory experiments and from field observations it was observed that tidal inundation inhibited *Salicornia* growth, while having no effect on *Spartina* growth. It is concluded that *Salicornia* exclusion from the *Spartina* zone is due to tidal immersion.

Keywords: San Francisco Bay, tidal marsh, soil, hydrodynamics, plant establishment, plant ecology

76-14. Mahrdt, C.R., T.A. Oberbauer, J.P. Rieger, J.R. Verfaillie, B.M. Browning and, J.W. Speth (1976), "The Coastal Wetlands of Northern Santa Barbara County," Coastal Wetland Series No. 14, California Department of Fish and Game, Sacramento, California.

The coastal wetlands of northern Santa Barbara County are located approximately 45 miles north of the City of Santa Barbara. The wetland environs, resources, resource uses and problems are characterized in the report.

Keywords: Southern California, tidal marsh, freshwater marsh, ecology, inventory

76-15. Mudie, P.J., B.M. Browning, and J.W. Speth (1976), "The Natural Resources of San Dieguito and Batiquitos Lagoons,", Coastal Wetland Series No. 12, California Department of Fish and Game, Sacramento, California.

The San Dieguito Lagoon was confined to one main channel after construction of a nearby racetrack. A railroad and two interstate highways crisscross the lagoon and have cut off large areas of marsh to tidal flow. Batiquitos Lagoon is also limited by roads and railroads and development pressure on its periphery. Both lagoons are cut off from tidal flow at least during the summer months due to sand bar formation at their mouths. The salinity in the lagoons ranges from 8 to 54 ppt. The harsh environment is uninhabitable for fish. Discharge of sewage effluent into the lagoons was conducted until 1974. A thick layer of sludge still exists on the bottom of each lagoon and is causing problems with algal mats, odors, excess nutrients and BOD. Options are being considered to increase the tidal prisms and stabilize the lagoons as tidal ecosystems.

Keywords: Southern California, lagoon, water quality, salinity, ecology, inventory

76-16. Patrick, W.H., Jr. and K.R. Reddy (1976), "Nitrification-Denitrification Reactions in Flooded Soils and Water Bottoms: Dependence on Oxygen Supply and Ammonium Diffusion," *Journal of Environmental Quality*, vol. 5, no. 4, pp. 469-472.

In flooded soils, oxygen moving through the overlying water column causes the development of an aerobic surface layer of soil or sediment. Ammonium in the surface layer is nitrified, causing an ammonium gradient across the anaerobic-aerobic soil layers, and ammonium diffusing from the anaerobic layer to the aerobic layer. Nitrate formed from ammonium

nitrification diffuses downward due to a similar concentration gradient. Nitrate is converted to nitrous oxide and elemental nitrogen through denitrification.

Keywords: chemistry and nutrients, soil

76-17. Patrick, W.H., Jr., R.D. Delaune, R.M. Engler, and S. Gotoh (1976), "Nitrate Removal from Water at the Water-Mud Interface in Wetlands," Report No. EPA-600/3-76-042, U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, Corvallis, Oregon.

Nitrogen reactions that occur in the water-mud interface in wetlands are tested and discussed in detail. The oxidized and reduced layers in the flooded soil are characterized by vertical distribution of the oxidation-reduction (redox) potential and concentrations of manganous manganese, ferrous iron, sulfide, nitrate and ammonium. The apparent thickness of the oxidized layer was different when evaluated by distribution of the various components (manganese, iron, sulfide, etc.) in the profile. Nitrate is removed from floodwaters and reduced to elemental nitrogen. The concentration of atmospheric oxygen over a flooded soil was determined to be a factor in estimating the amount of nitrogen lost by denitrification. If oxygen is not limiting, ammonia nitrogen in a flooded soil or sediment exposed to oxygen from the water column undergoes sequential nitrification and denitrification.

Keywords: chemistry and nutrients, water quality, soil

76-18. San Francisco Bay Conservation and Development Commission (1976), "Suisun Marsh Protection Plan," San Francisco Bay Conservation and Development Commission, San Francisco, California.

The Suisun Marsh region's natural and man-made resources and their current and potential uses are described in the report. Guidelines to carry out the Suisun Marsh Protection Plan, and maps of the region detailing habitat types, geologic factors, management areas and lands recommended for acquisition are included.

Keywords: San Francisco Bay, tidal marsh, ecology, regulations, inventory

76-19. San Francisco Bay Conservation and Development Commission Staff (1976), "Suisun Marsh Environment," San Francisco Bay Conservation and Development Commission, San Francisco, California.

The habitat types of Suisun Marsh area are described, along with the area's physical features (geologic, soil, and seismic conditions). Proposed urban development around Suisun Marsh is also discussed. It is recommended to preserve marsh areas and limit urban development.

Keywords: San Francisco Bay, ecology

76-20. Smith, K.A. (1976), "The Natural Resources of the Nipomo Dunes and Wetlands," Coastal Wetland Series No. 15, California Department of Fish and Game, Sacramento, California.

The Nipomo Dunes and Wetlands are located approximately 20 miles south of the City of San Luis Obispo. The region's environs, natural resources, resource uses, and problems and conflicts are characterized in the report.

Keywords: Central California, tidal marsh, freshwater marsh, ecology, inventory

76-21. Spangler, F.L., W.E. Sloey, and C.W. Fetter Jr. (1976), "Wastewater Treatment by Natural and Artificial Marshes," Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma.

Artificial freshwater marshes consisting of plastic-lined excavations containing emergent vegetation (primarily *Scirpus validus*) growing in gravel were used to test the ability of marshes to treat wastewater. The water quality was improved after flowing through the artificial marshes. Harvesting of the vegetation was not a practical phosphorous removal technique.

Keywords: freshwater marsh, wastewater treatment

76-22. Speth, J.W., B.M. Browning, and K.A. Smith (1976), "The Natural Resources of Anaheim Bay-Huntington Harbour," Coastal Wetland Series No. 18, California Department of Fish and Game, Sacramento, California.

The wetlands of Anaheim Bay are described in terms of their geology, history, biology and ecology. The present resource problems are identified and suggestions are made for improvements.

Keywords: Southern California, ecology, inventory

76-23. Windom, H.L. (1976), "Geochemical Interactions of Heavy Metals in Southeastern Salt Marsh Environments," U.S. Environmental Protection Agency, Office of Research and Development, Corvallis Environmental Research Laboratory, Corvallis, Oregon.

A three-year study of the transport, fate, and geochemical interactions of several metals in the southeastern coastal littoral-salt marsh environment is summarized in the report.

Keywords: water quality, soil, monitoring, wastewater treatment

76-24. Wondolleck, J.T., W. Zolan, and G.L. Stevens (1976), "A Population Study of Harvest Mice in the Palo Alto Salt Marsh," *Wasmann Journal of Biology*, vol. 34, pp. 52-64.

In 1972, a study was conducted to determine some basic environmental parameters necessary for the survival of the endangered salt marsh harvest mouse. The marsh habitat was divided into five types for harvest mice, and density figures were derived for each habitat type. The majority of harvest mice collected preferred marsh containing tall, lush pickleweed (*Salicornia virginica*) mixed with saltbush (*Atriplex patula*) and alkali heath (*Frankenia grandifolia*). Marsh submergence was found to have reduced and restricted the salt marsh harvest mice population in the Palo Alto Marsh.

Keywords: San Francisco Bay, mammals, endangered species

77-01. Ariathurai, R. and R.B. Krone (1977), "Mathematical Modeling of Sediment Transport in Estuaries," In *Estuarine Processes, Volume II: Circulation, Sediments, and Transfer of Material in the Estuary*, pp. 98-106, Academic Press, Inc., San Francisco, California.

Sediment transport equations and models for estuaries are reviewed in the paper. The emphasis of the paper is on erosion and depositional characteristics of cohesive sediments. Specific information on salt marshes is not included in the article.

Keywords: sedimentation

77-02. DiSalvo, L.H. (1977), "Environmental Effects of Dredging and Disposal in the San Francisco Bay Estuarine System," Draft Final Report to the Association of Bay Area Governments, Berkeley, California.

The basic characteristics (structure and water circulation, sediments, chemical processes, biology, and dredging) of the San Francisco Bay Estuary are described. The direct and indirect effects of dredging are discussed in detail as well as the agencies involved in dredging permit applications.

Keywords: San Francisco Bay, chemistry and nutrients, sedimentation, dredging, permitting

77-03. Garbisch, E.W. (1977), "Recent and Planned Marsh Establishment Work Throughout the Contiguous U.S., A Survey and Basic Guidelines," Contract Report D-77-3, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

A survey of marsh restoration projects that had been completed for at least one year yielded 105 responses from across the contiguous U.S. Of the 105 projects, 9 were totally unsuccessful and 59 were purely experimental. A majority of the projects were undertaken in coastal salt marsh environments on the east coast. Questionnaire responses were analyzed and summarized in the report. Recommendations were included for site preparation, establishment, maintenance and management.

Keywords: San Francisco Bay, tidal marsh, plant establishment, marsh restoration, planning, inventory

77-04. Harvey, H.T., H.L. Mason, and T.W. Wooster (1977), "The Marshes of San Francisco Bay: Their Attributes and Values," San Francisco Bay Conservation and Development Commission, San Francisco, California.

The major marshes of San Francisco Bay are described. Topics include the dynamics of saltwater marshes, plant associations of S.F. Bay marshes, preservation of natural marshes, the value of marshes and marsh restoration. Guidelines for a marsh inventory are also outlined.

Keywords: San Francisco Bay, tidal marsh, ecology, marsh restoration, plant ecology, inventory

77-05. Knutson, P.L. (1977), "Designing for Bank Erosion Control With Vegetation," pp. 716-733, Reprint 78-2, Reprinted for the U.S. Army, Coastal Engineering Research Center, Fort Belvoir, Virginia.

The use of vegetation to control bank erosion has proven to be very effective and cost efficient. Design criteria are given for determining site suitability, selecting plant materials and planting methods, and estimating labor requirements on a project by project basis.

Keywords: San Francisco Bay, Central California, tidal marsh, erosion control, plant establishment

77-06. Knutson, P.L. (1977), "Planting Guidelines for Marsh Development and Bank Stabilization," U.S. Army Corps of Engineers Coastal Engineering Research Center, Fort Belvoir, Virginia.

Important factors when choosing a particular plant species for establishment are geographical area, tidal elevation, tidal range, fetch length, salinity, and soil properties. A key is provided to aid in selecting the proper plants for the area under consideration. The only West Coast plant included in the guidelines is *Spartina foliosa*. Recommendations for planting seeds, sprigs, plugs and nursery seedlings are given in terms of propagation, establishment, fertilization, and maintenance.

Keywords: plant establishment, tidal marsh, maintenance, plant ecology

77-07. Lahti, T. (1977), "Restoration of a Small Suburban Southern Wisconsin Wetland," In C.B. DeWitt and E. Soloway (eds.), *Wetlands Ecology, Values, and Impacts*, pp. 136-161, Institute for Environmental Studies, University of Wisconsin, Madison, Wisconsin.

The vegetation of four southern Wisconsin wetlands was analyzed along an environmental gradient. Complex interactions of hydrologic, edaphic, biotic and physiographic influences were thought to be responsible for the present patterns of wetland vegetation distribution. After each factor was measured individually for correlations with vegetation, physiographic variability was considered primarily responsible for vegetational zonation by influencing the hydrologic, edaphic and biotic conditions. Vegetation was chosen for the small wetland restoration project based on the above findings. The project was moderately successful, but the actual marsh restoration procedures are not described.

Keywords: freshwater marsh, marsh restoration

77-08. MacDonald, K.B. (1977), "Coastal Salt Marsh," In M.G. Barbour and J. Major (eds.), *Terrestrial Vegetation of California*, pp. 263-294, John Wiley & Sons, New York.

The emphasis of the chapter is on the salt marsh vegetation of California. Descriptions of the more common plant species are provided. Vertical zonation of marsh vegetation is discussed and salt marsh development models are described. Other parameters vital to salt marsh development, such as sedimentation, drainage, marsh topography, salinity, and nutrients, are also discussed in the chapter.

Keywords: plant ecology, sedimentation

77-09. Madrone Associates (1977), "The Natural Resources of Napa Marsh," Coastal Wetland Series No. 19, California Department of Fish and Game, Sacramento, California.

The Napa Marsh is located approximately 27 miles north of San Francisco along a northern section of San Francisco Bay (San Pablo Bay). The environs, natural resources, fish and wildlife ecology, land and natural resource uses, and problems of the marsh are characterized in the report.

Keywords: San Francisco Bay, tidal marsh, ecology, inventory

77-10. Madrone Associates (1977), "The Natural Resources of Esteros Americano and de San Antonio," Coastal Wetland Series No. 20, California Department of Fish and Game, Sacramento, California.

The Esteros Americano and de San Antonio are relatively undisturbed estuaries located in Marin and Sonoma Counties. The environs, natural resources, fish and wildlife ecology, land and natural resource uses, and problems of the two estuaries are characterized in the report.

Keywords: Central California, tidal marsh, freshwater marsh, ecology, inventory

77-11. Nybakken, J., G. Cailliet, and W. Broenkow (1977), "Ecologic and Hydrographic Studies of Elkhorn Slough, Moss Landing Harbor and Nearshore Coastal Waters," Moss Landing Marine Laboratories, Moss Landing, California.

Quantitative and qualitative analyses of benthic invertebrates, fishes, larval fishes and zooplankton in the Elkhorn Slough area were completed. The data collected will become baseline information for future studies. Various water quality parameters were also studied and the methods used to determine the water quality parameters are described.

Keywords: Central California, invertebrates, fish, tidal marsh, water quality, salinity, monitoring

77-12. Roberts, F.C. (1977), "Salt Marsh Restoration in Alameda County and Its Impact on Mosquito Control," In C.D. Grant (ed.), *Proceedings and Papers of the Forty-fifth Annual Conference of the California Mosquito and Vector Control Association, Inc.*, pp. 166-167, CMVCA Press, Visalia, California.

A description of some major failures by the Army Corp of Engineers in restoring the Hayward marsh to tidal action is provided. The implications of these failures go beyond mosquito control problems. The solutions that were implemented are also listed in the paper. The need for early involvement of mosquito abatement districts in salt marsh restoration projects is emphasized.

Keywords: San Francisco Bay, soil, planning, marsh restoration, mosquito control, construction

77-13. Smith, H.K. (1977), "Feasibility of Developing Biological Habitats on Dredged Material," In *Proceedings of the Ninth Dredging Seminar*, Texas A&M University, Sea Grant College, College Station, Texas.

The construction and development of marsh, terrestrial, island and aquatic habitat with the use of dredge spoil offers a way to create useful biological systems. The technological and economic feasibility of these four disposal alternatives are presented. Marsh and terrestrial habitat development are the best understood alternatives.

Keywords: dredge spoil, marsh restoration, construction

77-14. Tilton, D.L. (1977), "Wastewater Treatment Via Wetland Irrigation: Nutrient Dynamics," In C.B. DeWitt and E. Soloway (eds.), *Wetlands Ecology, Values, and Impacts*, pp. 178-197, Institute for Environmental Studies.

Approximately 10 million gallons of secondary effluent were discharged onto a ten acre section of wetland. Total dissolved phosphorous, ammonium-N, nitrate+nitrite-N, and chlorine were measured in the effluent and in surface waters various distances (30 to 255 m) from the discharge location. Element budgets showed that 99, 95, and 71 percent of the total input of nitrate+nitrite-N, total dissolved P, and ammonium-N, respectively, were immobilized within 30 m of the discharge site. Chlorine concentrations were reduced slightly, but the reductions were mostly due to dilution.

Keywords: freshwater marsh, water quality, chemistry and nutrients, wastewater treatment

77-15. U.S. Army Corps of Engineers (1977), "Dredge Disposal Study, San Francisco Bay and Estuary: Main Report," U.S. Army Corps of Engineers, San Francisco, California.

Specific data on the composition and properties of San Francisco Bay sediments are presented. Areas that were addressed include; pollutant distribution, biological impacts, sediment characteristics, impacts of dredging, and open water release of dredged materials. Some cost figures and suggested sites for marsh creation as a disposal option are presented. Marsh creation is described as an acceptable option for the disposal of dredge materials. However, each project must be evaluated on a case-by-case basis. Additional information related to marsh restoration can be found in Appendix K of the study.

Keywords: San Francisco Bay, water quality, soil, dredging, dredge spoil

77-16. Windom, H.L. (1977), "Ability of Salt Marshes to Remove Nutrients and Heavy Metals from Dredged Material Disposal Area Effluents," Technical Report D-77-37, U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

A study was conducted in Georgia to determine a salt marsh's ability to remove pollutants contained in runoff from a dredge spoil disposal area. Nitrogen, phosphorous, iron, manganese, cadmium, copper, nickel, and zinc concentrations decreased after passing through the marsh. The contaminants accumulated in the sediments with only minor increases in the salt marsh vegetation.

Keywords: dredge spoil, tidal marsh, chemistry and nutrients, wastewater treatment

77-17. Zedler, J.B. (1977), "Salt Marsh Community Structure in the Tijuana Estuary, California," *Estuarine and Coastal Marine Science*, vol. 5, pp. 39-53.

A study was undertaken to determine how the presence and distribution of species changed with elevation, and if the species arranged themselves in groups relating to elevation and competition. There was a change in dominant species with an increase in elevation, but the change was very gradual. Zonation was non-existent with the exception of exclusive stands of *Spartina foliosa* below 0.6 to 0.7 m above MSL. The role of competition may not be very important. It appeared that timing of growth and type of reproduction allow similar species to coexist.

Keywords: Southern California, tidal marsh, plant ecology

77-18. Zetterquist, D. (1977), "The Salt Marsh Harvest Mouse (*Reithrodontomys raviventris raviventris*) in Marginal Habitats,", *Wasmann Journal of Biology*, vol. 35, pp. 68-76.

The possibility that the salt marsh harvest mouse was using marginal habitats was investigated in South San Francisco Bay. The study confirmed that marginal habitats were being used by the salt marsh harvest mouse.

Keywords: San Francisco Bay, endangered species, mammals

78-01. Anonymous (1978), "Larkspur Ferry Terminal Draft Marsh Restoration Program," Presented for Review to the Muzzi Marsh Technical Advisory Committee to the Golden Gate Bridge, Highway and Transportation District.

The design specifications for the Muzzi Marsh restoration project are given. Information about dike breach modification, channel construction (and specifications), site grading, planting, monitoring, and other construction work is included.

Keywords: San Francisco Bay, marsh restoration, construction, plant establishment, monitoring

78-02. Allen, H.H., E.J. Clairain, Jr., R.J. Diaz, A.W. Ford, L.J. Hunt, and B.R. Wells (1978), "Habitat Development Field Investigations, Bolivar Peninsula Marsh and Upland Development Site, Galveston Bay, Texas; Summary Report," Technical Report D-78-15, U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

The results of habitat development field investigations in Bolivar Peninsula (Galveston Bay, Texas) are discussed. Equipment choices, construction methods, plant selection and planting methods are all described. The use of the man-made marsh by fish, invertebrates, reptiles and amphibians, birds and mammals is also evaluated and compared to pre-marsh conditions.

Keywords: construction equipment, marsh restoration, construction, plant establishment, monitoring

78-03. Boto, K.G. and W.H. Patrick, Jr. (1978), "Role of Wetlands in the Removal of Suspended Sediments," In P.E. Greeson, J.R. Clark and J.E. Clark (eds.), *Wetland Functions and Values: The State of Our Understanding*, pp. 479-489, American Water Resources Association, Minneapolis, Minnesota.

Wetlands are generally very effective at removing suspended sediment loads. Flow rates decrease and sediments are deposited through wetlands due to a smaller elevation gradient and the presence of vegetation. Fresh water-salt water interfaces also enhance particle sedimentation because of the ionic effects salt water has on charged clay particles. Wetlands serve as sinks for pesticides, heavy metals and other pollutants. However, not enough is known about the long-term effects of the pollutants on marsh productivity and the food chain.

Keywords: sedimentation, wastewater treatment

78-04. Eckert, J.W. (1978), "Design of Retention Structures for Marsh Habitats," In Coastal Zone '78: The Proceedings of the Symposium on Technical, Environmental, Socioeconomic and Regulatory Aspects of Coastal Zone Management, Reprinted for the U.S. Army, Coastal Engineering Research Center, Fort Belvoir, Virginia.

Sand dikes and sand bag dikes have been used as retention structures and protective barriers for dredge disposal sites that are developed into marsh habitat. Site selection, design parameters, structural types and some examples of retention and protective structures are discussed.

Keywords: marsh restoration, construction

78-05. Eckert, J.W., M.L. Giles, and G.M. Smith (1978), "Design Concepts for In-Water Containment Structures for Marsh Habitat Development," Technical Report D-78-31, U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia.

General guidance for structure selection, and development of structure design concepts, for use in habitat development are provided in the report. Various types of structures are reviewed including sand dikes, sheet piles, fabric bags, gabions, cofferdams, and breakwaters. Preliminary design information and concepts are discussed and references are provided for the detailed design of these structures.

Keywords: construction, structures

78-06. Environmental Laboratory (1978), "Wetland Habitat Development with Dredged Material: Engineering and Plant Propagation," Technical Report DS-78-16, U. S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

Marsh development on dredged materials was shown to be a feasible alternative to traditional methods at experimental sites on the Atlantic, Gulf, and Pacific coasts. Guidelines are presented for planning, engineering and construction, plant propagation monitoring and potential problems, and costs. Emphasis is placed on two major areas: engineering and plant propagation.

Keywords: plant establishment, dredge spoil, marsh restoration, dredging

78-07. Gannon, P.T., Sr., J.F. Bartholic, and R.G. Bill, Jr. (1978), "Climatic and Meteorological Effects of Wetlands," In P.E. Greeson, J.R. Clark and J.E. Clark (eds.), *Wetland Functions and Values: The State of Our Understanding*, pp. 576-588, American Water Resources Association, Minneapolis, Minnesota.

Wetlands affect the climate (local, regional) in several important ways. Wetlands tend to moderate temperatures because they have high thermal inertias (slow to heat or cool). Studies have shown that destruction of wetlands can lead to increased summer temperatures and decreased winter temperatures. Wetlands are an important source of water vapor and also play a key role in the formation of sea and lake breezes.

Keywords: ecology

78-08. Kadlec, R.H. (1978), "Wetlands for Tertiary Treatment," In P.E. Greeson, J.R. Clark and J.E. Clark (eds.), *Wetland Functions and Values: The State of Our Understanding*, pp. 490-504, American Water Resources Association, Minneapolis, Minnesota.

Current information on the use of fresh water wetlands to treat tertiary wastewater is reviewed. Fresh water wetlands have exhibited significant potential for water quality improvement, although many biological and chemical processes are not yet well understood. Methods used to determine wetland performance are discussed as are time effects (diurnal, daily, annual) and geographic differences. The need for more information about wetlands and their ability to treat wastewater is emphasized.

Keywords: freshwater marsh, wastewater treatment

78-09. Kadlec, R.H. and J.A. Kadlec (1978), "Wetlands and Water Quality," In P.E. Greeson, J.R. Clark and J.E. Clark (eds.), *Wetland Functions and Values: The State of Our Understanding*, pp. 436-456, American Water Resources Association, Minneapolis, Minnesota.

Wetlands are able to tolerate natural and anthropogenic changes very well. Wetlands have shown an ability to chemically change, biologically alter and/or store a variety of water related inputs including nitrogen, phosphorous, heavy metals, pesticides and industrial wastes. A summary of several past studies is provided in the article.

Keywords: freshwater marsh, water quality, wastewater treatment

78-10. Krone, R.B. (1978), "Hydrologic Evaluation of the Proposed Muzzi Marsh Restoration," Unpublished Report Prepared for the Golden Gate Bridge, Highway and Transportation District.

The hydraulic features of the proposed marsh restoration project were evaluated. Recommendations were given for dike breach modification, and channel design and construction. Channels were designed to facilitate deposition of soft new mud, which is

desirable for the establishment of *Spartina foliosa*. To promote sedimentation and minimize construction costs, the channels should have rectangular cross-sections.

Keywords: San Francisco Bay, hydrodynamics, marsh restoration, plant establishment, sedimentation

78-11. Kruczynski, W.L., R.T. Huffman, and M.K. Vincent (1978), "Habitat Development Field Investigations Apalachicola Bay Marsh Development Site Apalachicola Bay, Florida," Technical Report D-78-32, U. S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

Dredged spoil was added to an island in the Apalachicola Bay as part of a cordgrass planting experiment. *Spartina alterniflora* was planted in fine-grained material in the intertidal area. *Spartina patens* was planted in coarse-grained material in supratidal areas. Survival, cover, presence of inflorescences and culm density were noted for transplant spacings of 0.3, 0.6, 0.9, 1.8, 2.7 m. *S. alterniflora* had much better culm density, survival and cover for spacings of 0.3-0.9 m. Highest growth in *S. patens* was observed for spacings of 1.8 and 2.7 m.

Keywords: marsh restoration, plant establishment

78-12. Livingston, R.T. and O.L. Loucks (1978), "Productivity, Trophic Interactions, and Food-Web Relationships in Wetlands and Associated Systems," In P.E. Greeson, J.R. Clark and J.E. Clark (eds.), *Wetland Functions and Values: The State of Our Understanding*, pp. 101-119, American Water Resources Association.

A review of the current information regarding production, trophic interaction, and food-web relationships in wetlands is given. From the literature review it was concluded that production and food-web relationships in wetlands and their downstream dependent systems are partly affected by regional climatic and hydrologic characteristics of the watersheds in which they are located. The wetland and its watershed control nutrient and energy transport, gradients of physio-chemical variables and timing of responses in the wetland and adjacent systems.

Keywords: tidal marsh, freshwater marsh, ecology

78-13. Lunz, J.D., R.J. Diaz, and R.A. Cole (1978), "Upland and Wetland Habitat Development with Dredged Material: Ecological Considerations," Technical Report DS-78-15, U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

With proper planning, including the consideration of regional goals, dredged material habitats can be both visually and functionally compatible with surrounding natural areas. Upland, island, wetland and aquatic habitats can be developed and are discussed. It is important to understand the values of existing habitats before deciding to replace them with new habitats.

Keywords: dredge spoil, ecology, marsh restoration, planning

78-14. Morris, J.H., C.L. Newcombe, R.T. Huffman, and J.S. Wilson (1978), "Habitat Development Field Investigations, Salt Pond No. 3 Marsh Development Site, South San Francisco Bay, California; Summary Report," Technical Report D-78-57, U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

An abandoned salt pond was used to create marsh habitat. Dredged material was used to bring the settled salt pond area up to the proper elevations for salt marsh vegetation. After drying, several deep cracks developed. Tractor tilling did not produce better substrate than did flooding with tidal water to soften the mud (not enough to justify tilling costs). Several tests were conducted to determine the best methods for marsh creation. It is recommended that *Spartina foliosa* sprigs be planted in early spring at 0.5 to 1.0 m intervals in the lower two-thirds of the intertidal zone and at low wave energy sites. Plant species such as pickleweed will naturally colonize the upper third of the intertidal zone. It took approximately two growing seasons for the sprigs to produce satisfactory cover. Seeding was not successful. Cost estimates for plant establishment are given.

Keywords: San Francisco Bay, marsh restoration, plant establishment, dredge spoil

78-15. Odum, E.P. (1978), "The Value of Wetlands: A Hierarchical Approach," In P.E. Greeson, J.R. Clark and J.E. Clark (eds.), *Wetland Functions and Values: The State of Our Understanding*, pp. 16-25, American Water Resources Association, Minneapolis, Minnesota .

The methods of assigning values (economic, productiveness, global, etc.) are discussed along with the problems associated with each method. Some of the methods include the common denominator approach, the scaling and weighing approach, and the replacement value approach.

Keywords: economic value, planning

78-16. Onuf, C.P., M.L. Quammen, G.P. Shaffer, C.H. Peterson, J.W. Chapman, J. Cermak, and R.W. Holmes (1978), "An Analysis of the Values of Central and Southern California Coastal Wetlands," In P.E. Greeson, J.R. Clark, and J.E. Clark (eds.), *Wetland Functions and Values: The State of Our Understanding*, American Water Resources Association, Minneapolis, Minnesota.

A study was conducted to determine the value of Southern and Central California wetlands in terms of primary productivity, exportation of organic matter to coastal waters, and importance as nursery areas for coastal fish stocks. It was discovered that Southern and Central California wetlands are much less productive than Atlantic Coast wetlands, exportation of organic matter is not occurring on any significant level, and that the wetlands are not important nursery areas for coastal fish. However, the wetlands do have other important values including habitat for endangered species, stopping places for migratory birds, education and research, and aesthetics.

Keywords: Southern California, Central California, chemistry and nutrients

78-17. Osvald, S. and C.W. Belin (1978), "Corps Permit Processing," In P.E. Greeson, J.R. Clark and J.E. Clark (eds.), *Wetland Functions and Values: The State of Our Understanding*, pp. 50-56, American Water Resources Association, Minneapolis, Minnesota.

The Army Corps of Engineers' section 10 and section 404 permit processing steps are described. The permit process includes receiving and acknowledging the application, issuing a public notice, accepting comments from the public and other agencies and finally, making a decision or recommendation. The Corps' methods for evaluating wetlands are also briefly described.

Keywords: permitting

78-18. Reimhold, R. J., M.A. Hardisky, and P.C. Adams (1978), "Habitat Development Field Investigations Buttermilk Sound Marsh Development Site Atlantic Intracoastal Waterway, Georgia, Appendix A," Dredged Material Research Program Technical Report D-78-26, Office, Chief of Engineers, U. S. Army, Washington D. C.

Results of a field study to test the feasibility of developing a marsh on dredged material in Georgia. Optimum times for *Spartina alterniflora* transplantation were determined to be between March and April.

Keywords: dredge spoil, tidal marsh, plant ecology, water quality, marsh restoration, soil, salinity, dredging, monitoring, plant establishment

78-19. Smart, M.R. and J.W. Barko (1978), "Influence of Sediment Salinity and Nutrients on the Physiological Ecology of Selected Salt Marsh Plants," *Estuarine and Coastal Marine Science*, vol. 7, pp. 487-495.

An investigation of the influence of salinity and nutrients on the physiological ecology of *Spartina alterniflora*, *S. foliosa*, *S. patens* and *Distichlis spicata* was conducted under simulated tidal inundation. Growth differences with regard to sediment type were attributed to differences in sediment salinity and nutrients. The salt-excreting plant species above were also shown to be capable of ion exclusion, which in some cases resulted in increased sediment salinity. Selective uptake of potassium was demonstrated and tissue potassium was found to be linearly related to sediment salinity.

Keywords: tidal marsh, salinity, chemistry and nutrients, soil

78-20. Smith, H.K. (1978), "An Introduction to Habitat Development on Dredged Material," Technical Report DS-78-19, U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

Dredged material disposal alternatives involving habitat development, including marsh, terrestrial, island and aquatic habitats, are discussed in the report. Procedural guidelines are given for the planning and evaluation of each of the four disposal alternatives. Construction techniques are not discussed.

Keywords: dredge spoil, marsh restoration, planning

78-21. Soots, R.F., Jr., and M.C. Landin (1978), "Development and Management of Avian Habitat on Dredged Material Islands," Technical Report DS-78-18, U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

Seven studies were conducted to determine dredged material island use by nesting waterbirds. All the studies were done outside of California, the closest occurring in Oregon/Washington. The regional studies are discussed, as are the habitat requirements of colonial waterbirds. Another section of the report includes information about bird monitoring techniques, vegetation for dredged material islands and management problems.

Keywords: dredge spoil, birds, marsh restoration, monitoring, plant establishment

78-22. Vincent, M.K. (1978), "Habitat Field Investigation, Rennie Island Marsh Development Site Grays Harbor, Washington.: Summary Report," Technical Report D-78-11, U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

A marsh creation project of 10 to 15 acres was planned for Rennie Island in Grays Harbor, Washington. The marsh would have been created out of dredged spoil placed behind two containment structures. An engineering investigation was performed on the foundation soils and a determination was made that the soils were very silty and would require costly design features to support sufficient dikes. Alternative structures and sites were considered, but none could conform to the time and cost schedule.

Keywords: dredge spoil, plant establishment, planning

78-23. de la Cruz, A.A. (1978), "Production and Transport of Detritus in Wetlands," in P.E. Greeson, J.R. Clark and J.E. Clark (eds.), *Wetland Functions and Values: The State of Our Understanding*, pp. 162-174, American Water Resources Association, Minneapolis, Minnesota.

Decomposition rates of estuarine and marine plants vary from 35 to 96 percent. There are virtually no data on decomposition rates for root materials, although preliminary studies indicate a much slower rate. Net exports and net imports of carbon and have been attributed to differences in hydrologic features, to the proximity of fresh water input, to the geomorphic orientation of the drainage system, to meteorological phenomena, and to the nature of the particles being transported. Organic carbon moves from wetland areas to aquatic systems in the form of floating plant fragments, suspended particulate detritus, traction materials (materials that move along bottom surfaces), and dissolved organic substances leached from decaying plant tissues and organic sediments.

Keywords: chemistry and nutrients, tidal marsh, plant ecology

79-01. Atwater, B.F., S.G. Conard, J.N. Dowden, C.W. Hedel, R.L. MacDonald, and W. Savage (1979), "History, Landforms, and Vegetation of the Estuary's Tidal Marshes," in T.J. Conomos (ed.), *San Francisco Bay: The Urbanized Estuary*, pp. 347-386, Pacific Division, American Association for the Advancement of Science, San Francisco, California.

Tidal marshes around S.F. Bay typically contain 13 or 14 species of vascular plants that are characteristic of all salt marshes. The Delta region contains about 40 species that are characteristic of freshwater marshes. These contrasting communities overlap around San Pablo Bay, Carquinez Straight and Suisun Bay. The vegetation within the different marsh regions is described, along with the history of San Francisco Bay and its marshes. The plant species and their locations within San Francisco Bay are listed in an appendix. It is estimated that the vascular plants of the tidal marshes collectively contribute about 10 billion grams of carbon per year to other parts of the estuary, which is 20 times less than the estimate of algae carbon production.

Keywords: San Francisco Bay, chemistry and nutrients, tidal marsh, plant ecology

79-02. Briscoe, J. (1979), "Legal Problems of Tidal Marshes," In T.J. Conomos (ed.), *San Francisco Bay: The Urbanized Estuary*, pp. 387-400, Pacific Division, American Association for the Advancement of Science, San Francisco, California.

Three legal problems that afflict tidal marshes are: (1) the rights and liabilities of persons seeking to alter the natural condition of a marsh, (2) boundaries of ownership interests within a marsh and (3) boundaries of the jurisdictions of government agencies having power to regulate filling, dredging or other activities within the marsh. Examples of the legal problems are discussed.

Keywords: legal problems, regulations

79-03. California Department of Fish and Game (1979), "Endangered Wildlife of California," California Department of Fish and Game, Sacramento, California.

The description, distribution, life history, and status of the endangered species of California are discussed briefly in the pamphlet.

Keywords: endangered species

79-04. California State Coastal Conservancy and the City of Del Mar (1979), "San Dieguito Lagoon Resource Enhancement Program," California State Coastal Conservancy, Oakland, California, and City of Del Mar, Del Mar, California.

The mouth to San Dieguito Lagoon has been closed year-round since the 1940's due to upstream dams, wetland filling, and sedimentation. An enhancement program is proposed to increase the tidal prism by 40 to 70 percent and hopefully maintain permanent ocean exchange. Tidal basins will be excavated and channels will be deepened and widened. Wildlife habitat, including least tern nesting areas and Belding's savannah sparrow habitat, is to be enhanced and created.

Keywords: Southern California, lagoon, marsh restoration

79-05. Clark, J., (ed.) (1979), "Ballona Wetlands Study (Final)," The Conservation Foundation, School of Architecture and Urban Planning, University of California, Los Angeles, California.

The Ballona Wetlands are the last remaining large tract of wetlands in Los Angeles County. There is considerable pressure to develop the wetlands as a marina and housing/commercial area. The wetlands are degraded, but a large portion of the tract is considered restorable. The restoration project would cost an estimated $290,000 and would entail reshaping the wetlands, constructing new tidal inlets, and installing fences and walkways.

Keywords: Southern California, tidal marsh, marsh restoration, regulations

79-06. Clark, J., (ed.) (1979), "Options for the Ballona Creek Wetlands, Draft Working Papers," School of Architecture and Urban Planning, University of California, Los Angeles, California.

Approximately nine hundred acres of wetlands remain from an original total of 1,600 acres. Only one hundred acres are presently influenced by tidal flow. The predominant plant genus in the salt marsh is *Salicornia*. *Spartina* is not present. Many alterations have been made to the circulation system of the marsh. Restoration goals and objectives, as well as the development threats are outlined in the report.

Keywords: Southern California, tidal marsh, freshwater marsh, marsh restoration, ecology

79-07. Conomos, T.J. (1979), "Properties and Circulation of San Francisco Bay Waters," In T.J. Conomos (ed.), *San Francisco Bay: The Urbanized Estuary*, pp. 47-84, Pacific Division, American Association for the Advancement of Science, San Francisco, California.

The physical setting of the San Francisco Bay is described, including bathymetry, climate, and tides. Circulation and mixing of Bay waters are also discussed in detail.

Keywords: San Francisco Bay, hydrodynamics

79-08. Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe (1979), "Classification of Wetlands and Deepwater Habitats of the United States," U.S. Fish and Wildlife Service, United States Department of Interior, Washington, D.C.

A classification system is presented for use in the National Wetlands Inventory. Wetlands and deepwater habitats are divided into five different systems; Marine, Estuarine, Riverine, Palustrine, and Lacustrine. The systems are further broken down into subsystems, classes and subclasses. Dominant plant species are used to characterize the areas and modifiers can be applied to describe the water and soil. Ecoregions are delineated in the report and the California coast falls within two provinces, the Californian and the Columbian.

Keywords: classification, regulations

79-09. Faber, P.M. (1979), "Draft Report on the Current Status of the Muzzi Marsh," Prepared for the Golden Gate Bridge, Highway and Transportation District.

Muzzi Marsh is located in Marin County (San Francisco Bay Area). The 125 acre site was restored to tidal activity when the dikes were breached in 1976. The current conditions (i.e. vegetation, soil, productivity, and bird use) of the restored marsh are summarized.

Keywords: San Francisco Bay, soil, marsh restoration, monitoring, plant establishment

79-10. Jones and Stokes Associates, Inc., Harvey and Stanley Associates, Inc., and John Blaney Associates (1979), "Protection and Restoration of San Francisco Bay Fish and Wildlife Habitat," Volumes 1 and 2, U.S. Fish and Wildlife Service and California Department of Fish and Game, Sacramento, California.

Existing San Francisco Bay habitats, the wildlife that utilizes each of the habitats, development pressures, and the roles of various government agencies are discussed in the two volume report. Habitat types and wildlife use are discussed in detail. Many maps are included in the report.

Keywords: San Francisco Bay, ecology, marsh restoration, endangered species, permitting

79-11. Krone, R.B. (1979), "Sedimentation in the San Francisco Bay System," In T.J. Conomos (ed.), *San Francisco Bay: The Urbanized Estuary*, pp. 85-96, Pacific Division, American Association for the Advancement of Science, San Francisco, California.

Since the 1860's, man has significantly altered the sediment inflows to the San Francisco Bay. Mining and agriculture caused large increases in sediment inflows during the late 1800's. Currently, sediment inflows are decreasing substantially due to increased freshwater diversion. Sediments enter the system via land drainage during the high winter river flows and initially settle in the upper bays. Spring and summer wave action resuspends the fine particles and they are transported around the bay and to the ocean by wind-driven currents and tidal currents. Decreased fresh water inflows (and sediment loads) combined with increased wastewater inputs may cause a degradation of the Bay's water quality.

Keywords: San Francisco Bay, sedimentation

79-12. Newcombe, C.L., J.H. Morris, P.L. Knutson, and C.S. Gorbics (1979), "Bank Erosion Control with Vegetation, San Francisco Bay, California," Miscellaneous Report No. 79-2, U.S. Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Virginia.

Cordgrass (*Spartina foliosa*) seeds, sprigs, plugs and bioconstructs (cordgrass-mussel plugs) were used in attempts to stabilize bank erosion in San Francisco Bay. Seeding was completely unsuccessful. In areas of moderate wave action, sprigs and plugs also failed, although plugs lasted longer than sprigs. The bioconstructs were not successful at every site, but in general they survived very well. Once the bioconstructs became established they were very effective at bank stabilization. It was determined that bioconstructs can be established without wave-stilling devices in areas where the fetch (distance over water the wind travels prior to reaching the site) is less than 7 kilometers. The biomass of 23 cordgrass marshes around the bay was similar to that of East Coast smooth cordgrass (*Spartina alterniflora*) marshes.

Keywords: San Francisco Bay, erosion control, marsh restoration, plant establishment

79-13. Schumacher, M. (ed.) (1979), *Seawater Corrosion Handbook*, Noyes Data Corporation, Park Ridge, New Jersey.

Special sections on the effects of marine organisms and the behavior of non-metal materials in the environment are included in the handbook. The handbook also includes annotated bibliographies for additional references on specific materials.

Keywords: corrosion, construction, structures, maintenance

79-14. Shuldiner, P.W., D.F. Cope, and R.B. Newton (1979), "Ecological Effects of Highway Fills on Wetlands, User's Manual," Transportation Research Board, National Research Council, Washington, D.C.

Ecological effects of highway fills and structures are discussed, including physical impacts and biological effects. Procedures are given for measuring the ecological effects of different construction and mitigation alternatives. Several mitigation techniques, including marsh creation are briefly described.

Keywords: ecology, construction, wastewater treatment

79-15. Siwolop, S. and H. Albert (1979), "California's Coastal Wetlands," California Sea Grant Report Series No. 2, CSGCP No. 69, California Sea Grant College Program, Institute of Marine Resources, University of California, La Jolla, California.

Coastal wetlands are a "dynamic edge between the land and the sea". The wetlands of California are diverse, dynamic, productive and threatened. Wildlife habitat is the primary function of importance of wetlands. Urbanization has affected California wetlands through marina development, filling for commercial and residential construction, and acceleration of erosion and sedimentation. Controls on watershed development are needed as well as innovative ways to remove excess sediment from the wetlands.

Keywords: ecology, sedimentation, marsh restoration

79-16. Sowers, G.F. (1979), *Soil Mechanics and Foundations: Geotechnical Engineering*, Fourth Edition, MacMillan Publishing Co., Inc., New York.

The textbook includes information on the nature of soil and rock, and how the properties of each affect foundation stability. Investigative techniques and construction methods are also discussed in the book.

Keywords: soil, construction

79-17. Teal, J.M., I. Valiela, and D. Berlo (1979), "Nitrogen Fixation by Rhizosphere and Free-Living Bacteria in Salt Marsh Sediments," *Limnology and Oceanography*, vol. 24, no. 1, pp. 126-132.

Conflicting results have been reported on the importance of nitrogen fixation in marshes. Observations for this study were made in the Great Sippewissett Marsh in Massachusetts.

Nitrogen fixation rates were measured in soil cores taken below the plant line and in various types of vegetated areas. The highest rates were always found in the top 10 mm of soil. Variations in the fixation rate were noticed with changes in the weather and changes in vegetation. The presence of ammonium can inhibit nitrogen fixation, but it probably is not significant at natural concentrations. The amount of nitrogen fixed in the Great Sippewissett is not enough to supply all of the needs of the present vegetation.

Keywords: chemistry and nutrients, water quality, tidal marsh

79-18. U.S. Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and California Department of Fish and Game (1979), "Elkhorn Slough Estuarine Sanctuary: Final Environmental Impact Statement," United States Department of Commerce, Washington, D.C.

Elkhorn Slough is being considered as a national estuarine sanctuary. The proposed area for the sanctuary is described, as are some alternatives that were rejected. The environmental impacts of the proposed actions are described.

Keywords: Central California, tidal marsh, ecology, planning, regulations, permitting

79-19. Valiela, I. and J.M. Teal (1979), "The Nitrogen Budget of a Salt Marsh Ecosystem," *Nature*, vol. 280, no. 23, pp. 652-656.

The study was performed in the Great Sippewissett Marsh in Massachusetts. The total inputs and outputs of nitrogen were determined and the results reflected an approximate steady-state balance. The equilibrium may be indicative of a mature salt marsh. The most important mechanism involved in exporting and importing nitrogen was tidal, and represented approximately 80 percent of the total exports. The rate of denitrification was greater than the rate of fixation, resulting in a net loss of nitrogen to the atmosphere.

Keywords: chemistry and nutrients, tidal marsh, water quality

79-20. Woodhouse, W.W., Jr. (1979), "Building Salt Marshes Along the Coasts of the Continental United States," Special Report No. 4, U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Virginia.

The important factors in marsh creation (elevation, slope, salinity and exposure) are discussed, by region, for the major coastal areas of the United States. Plant species and planting methods are also discussed on a regional basis.

Keywords: marsh restoration, plant establishment

80-01. Barnby, M.A. and V.H. Resh (1980), "Distribution of Arthropod Populations in Relation to Mosquito Control Recirculation Ditches and Natural Channels in the Petaluma Salt Marsh of San Francisco Bay," In *Proceedings and Papers of the Forty-eighth Annual Conference of the California Mosquito and Vector Control Association, Inc.*, pp. 100-102, California Mosquito and Vector Control Association, Inc., Visalia, California.

Arthropods and other insects were collected with vacuum suction devices and identified. Information is provided on the annual distribution, and relative location, of insect species to mosquito abatement ditches.

Keywords: San Francisco Bay, tidal marsh, insects

80-02. California State Coastal Conservancy (1980), "Wetlands Restoration and Enhancement Program: Project Guidelines and Procedures," California Coastal Conservancy, Oakland, California.

The procedures to obtain California Coastal Conservancy assistance (planning, financial, etc.) are outlined. The Conservancy will not provide public funds to restore wetlands as mitigation for environmental damage caused by other projects.

Keywords: marsh restoration, permitting

80-03. California Department of Fish and Game (1980), "Endangered, Rare, and Threatened Animals of California," California Department of Fish and Game, Sacramento, California.

The endangered, rare, and threatened animals of California are listed in the publication, along with their State and Federal status.

Keywords: endangered species

80-04. Garofalo, D. (1980), "The Influence of Wetland Vegetation on Tidal Stream Channel Migration and Morphology," *Estuaries*, vol. 3, no. 4, pp. 258-270.

Stream channel migration rates were lower in salt marshes than in freshwater marshes. The sinuosity of saline wetland channels was greater than that of freshwater channels. The difference is attributed to variations in vegetation types and the vegetation's soil holding capacity between saline and freshwater tidal wetland environments. Saline channels are lined with plants that have dense root systems (*Spartina alterniflora*, *S. patens*, and *Distichlis spicata*), while freshwater channels flow through a more homogeneous substrate and behave similarly to channels that cross mud flats in the intertidal zone.

Keywords: tidal marsh, freshwater marsh, hydrodynamics

80-05. Gosselink, J.G. and R.H. Baumann (1980), "Wetland Inventories: Wetland Loss Along the United States Coast," *Z. Geomorph. N.F.*, pp. 173-187, Suppl.-Bd. 34.

Past national wetland inventories are described in the article, as are some of the reasons for wetland losses.

Keywords: tidal marsh, inventory

80-06. Lewis, E.L. (1980), "The Practical Salinity Scale 1978 and Its Antecedents," *IEEE Journal of Oceanic Engineering*, vol. OE-5, no. 1, pp. 3-8.

An assessment of the measurement techniques for salinity is included in the article, along with a discussion of the Practical Salinity Scale 1978, which is recommended for international acceptance.

Keywords: salinity

80-07. Mason, H. L. (1980), "Techniques for Creating Salt Marshes Along the California Coast," In J. C. Lewis and E. W. Bunce (eds.), *Rehabilitation and Creation of Selected Coastal Habitats: Proceedings of a Workshop*, pp. 23-24, U.S. Fish and Wildlife Service, Biological Services Program, Washington, D.C.

The ability to grow *Spartina foliosa* from seed in San Francisco Bay salt marshes is discussed in the paper. The best results were obtained on dredge spoil "beyond the areas of the low-low tide and the high-low tide."

Keywords: dredge spoil, plant establishment

80-08. Phillips, R. C. (1980), "Creation of Seagrass Beds," In J. C. Lewis and E. W. Bunce (eds.), *Rehabilitation and Creation of Selected Coastal Habitats: Proceedings of a Workshop*, pp. 91-104, U. S. Fish and Wildlife Service, Biological Services Program, Washington, D.C.

The principal ecological function of eelgrass (*Zostera marina*) is to add energy to the detrital food chain. The plant also serves as a primary food source for the black brandt (*Brantus bernicula nigricans*) on the West Coast. The optimum temperature for eelgrass growth is between 10 and 20°C. Eelgrass may develop distinct sub-species based on high temperature tolerance. For this reason transplanting efforts should use local plant material only. The plant can withstand salinities of 20 to 35 ppt, prefers silty substrate, and will tolerate depths to 10 m below MLLW if sufficient light is available. The use of plugs is recommended in non-ideal locations, while individual plants cleaned of sediment can be used in areas considered optimal for growth. Attaching eelgrass to anchoring devices inhibits growth, but may be necessary in erosive environments.

Keywords: sea grasses, plant establishment

80-09. Rader, C.D. (1980), "A Restoration Proposal for the Ballona Wetlands," Thesis, M.A., School of Architecture and Urban Planning, University of California, Los Angeles.

The western portion of the Ballona Wetlands is the most functional and requires an additional inflow of saltwater for restoration. The increased input will improve the established *Salicornia* population and provide additional habitat for the Belding's savannah sparrow. The eastern portion will require the construction of a tidal inlet and the improvement of connections with other areas. Excavation of the eastern section to elevations of low to high marsh will provide necessary habitat diversity. Planting of *Spartina* in the newly created low marsh will hopefully attract the light-footed clapper rail. Specific planting methods and recommendations for equipment and structures are detailed in the proposal. The total cost is estimated at $684,000.

Keywords: Southern California, tidal marsh, marsh restoration, plant establishment, construction

80-10. Renshaw, D.L., R.A. Shleser, and G. Tchobanoglous (1980), "Bodega Harbor Marshland Study," Prepared for the California Coastal Commission, North Central Coast Region, Oakland, California.

A study was conducted to determine the impacts of two golf course holes on a small marsh at the southern end of Bodega Harbor. Recommendations were made to raise walkways, to discontinue mowing into the edges of the marsh and to drop clippings on the center of the fairways, not on the marsh periphery, to improve the affected marsh habitat. It was also recommended that the vegetation be monitored for an extended period of time to determine the effects of fertilizers, pesticides and herbicides on the marsh.

Keywords: Central California, tidal marsh, ecology, monitoring

80-11. Shapiro and Associates, Inc. (1980), "Humboldt Bay Wetlands Review and Baylands Analysis, Vol. I, II, III," Submitted to United States Army Corps of Engineers, San Francisco District, San Francisco, California.

The Humboldt Bay analysis was designed for use by the Army Corps of Engineers in reviewing permit applications for development of Humboldt Bay wetlands. Wetlands are identified and described in terms of their physical and biological characteristics. Wetlands of significant value are designated as either "Areas of Importance" or "Areas of Environmental Concern". Potential destruction or alteration would be discouraged in Areas of Importance. Activities in Areas of Environmental Concern would be carefully controlled. Potential activities within the wetlands are described along with their associated impacts and conflicts. Specific frameworks are provided for applicants and the Army Corps to assess the ramifications of proposed projects.

Keywords: Northern California, tidal marsh, freshwater marsh, ecology, planning, permitting, inventory

80-12. U.S. Army Corps of Engineers (1980), "Explore, Nos. 1-13: The California Coastline,", U.S. Army Corps of Engineers, San Francisco, California.

The explore series highlights tourist attractions along the California coastline and provides information on the ecosystems and physical conditions in each region. The explore series includes 13 regions.

Keywords: San Francisco Bay, Southern California, Northern California, Central California

80-13. U.S. Fish and Wildlife Service (1980), "California Least Tern Recovery Plan," U.S. Fish and Wildlife Service, Region 1, Portland, Oregon.

The California least tern is a Federal and State listed endangered bird that nests along the California coast. Preferred nesting habitat sites are open areas of sand and dried mud that are close to lagoons or estuaries. Protection of existing nesting habitat and the restoration of

degraded wetlands are necessary to increase the population of the species. Existing nesting sites and key habitat units are identified in the Recovery Plan.

Keywords: San Francisco Bay, Southern California, Central California, birds, endangered species

80-14. Zedler, J.B., T.P. Winfield, and P.B. Williams (1980), "Salt Marsh Productivity with Natural and Altered Tidal Circulation," *Oecologia*, vol. 44, pp. 236-240.

Measurements were taken of net aerial primary productivity (NAPP) in three Southern California Marshes during 1977 and 1978. The highest productivity was found in the area with the least amount of tidal circulation. It was determined that the large NAPP in this area was caused by entrapment of a large influx of freshwater which lowered soil salinity and created perfect growing conditions. Reduced tidal circulation will not always lead to increased productivity. If precipitation and runoff are low, hypersaline conditions can exist due to evaporation. The presence of thick stands of vascular plants may reduce algal productivity. Algae is a more valuable food source for the ecosystem.

Keywords: Southern California, plant ecology, salinity, soil, hydrodynamics

81-01. California Coastal Commission (1981), "Statewide Interpretive Guideline for Wetlands and Other Wet Environmentally Sensitive Habitat Areas," California Coastal Commission, Oakland, California.

The interpretive guideline was adopted as a basis for reviewing coastal permit applications. The authority for the guideline is found in the California Coastal Act of 1976. The permitted types of wetland development are outlined. Restoration is a permitted development, but various criteria must be met before approval is granted. Requirements are specified for dredging and filling operations including disposal practices and protection of plants and animals. Permits are required by at least the Army Corps of Engineers and the California Coastal Commission. The permitting process and the authority of the different agencies involved are detailed in an appendix.

Keywords: planning, dredging, regulations

81-02. Chan, E., T.A. Bursztynsky, N. Hantzsche, and Y.J. Litwin (1981), "The Use of Wetlands for Water Pollution Control," Municipal Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio.

A comprehensive review of the use of natural and artificial wetlands for wastewater and stormwater runoff treatment was completed. Major topics include wastewater characteristics, wetland pollutant removal mechanisms (physical, chemical and biochemical), hydrologic processes, case study reviews and research needs.

Keywords: wastewater treatment

81-03. Eilers, H.P. (1981), "Production in Coastal Salt Marshes of Southern California," U.S. Environmental Protection Agency, Corvallis, Oregon.

The productivity of salt marsh macrophytes is investigated in relation to soil salinity, pH, nitrogen, redox potential, water content, and tide level.

Keywords: Southern California, plant ecology

81-04. Hay, R.K.M. (1981), *Chemistry for Agriculture and Ecology*, Blackwell Scientific Publications, Boston, Massachusetts.

An emphasis is placed on the organic and physical chemistry of natural systems in this general chemistry textbook.

Keywords: chemistry and nutrients, water quality

81-05. Howes, B.L., R.W. Howarth, J.M. Teal, and I. Valiela (1981), "Oxidation-Reduction Potentials in a Salt Marsh: Spatial Patterns and Interactions with Primary Production," *Limnology and Oceanography*, vol. 26, no. 2, pp. 350-360.

Spartina alterniflora exists in a tall form and a short form along the Atlantic Coast. Salinity, and levels of iron and nitrogen don't totally explain the differences in morphology. Sediment oxidation-reduction potential (Eh) is higher in the root zone of the taller form than the shorter form. *Spartina* oxidizes sediments through release of oxygen and through internal metabolic processes. The larger, more productive plants create better oxidizing conditions which in turn provide the plant with more nutrients and encourage growth. The addition of fertilizers facilitates growth through increasing the oxidation potential of the sediments. The presence of water around the roots prevents oxygen diffusion and lowers Eh. The taller plants are found in areas where the water table is low.

Keywords: chemistry and nutrients, tidal marsh, water quality, soil

81-06. Knaggs, E.H. and R.W. Mall (1981), "Fish and Bivalves at Bolsa Chica Marsh Reestablishment Project," Progress Reports I, II, III, IV, Report Nos. 80-3, 80-5, 80-9, 81-4, State of California, Department of Fish and Game, Sacramento, California.

The tide gates of Bolsa Chica Marsh were opened in October, 1978. Monitoring for changes in fish and bivalve species and populations was completed over a course of ten months following the opening. The results of four sampling periods were compared to determine the effects of restoring tidal action. Limited population data were available for the area prior to marsh reestablishment, but these studies were also used for comparative purposes. The number of fish species inside the gates increased from two, prior to restoration, to twenty three, during the last sampling. The number of bivalves increased from two, prior to restoration, to nine species. The most species were found inside the marsh during periods when one or two of the three tide gates were left open for extended periods of time.

Keywords: Southern California, invertebrates, fish, tidal marsh, marsh restoration, monitoring

81-07. Niesen, T. and M.N. Josselyn (eds.) (1981), "The Hayward Regional Shoreline Marsh Restoration: Biological Succession During the First Year Following Dike Removal," Technical Report #1, Tiburon Center for Environmental Studies, San Francisco State University, Tiburon, California.

A study was conducted to determine the changes that occurred at a restored marsh site during the first year after the marsh was reintroduced to tidal flow. Vegetation establishment, soil conditions, fish utilization, benthic colonization, and bird populations were studied.

Keywords: San Francisco Bay, tidal marsh, fish, soil, marsh restoration, birds, invertebrates, plant establishment

81-08. Reneau, S.L. (1981), "Recent Sedimentation Along the Big River Estuary, Mendocino County," *California Geology*, vol. 34, no. 12, pp. 255-259.

A photographic history reveals that natural levees have formed along the Big River Estuary since the 1920's, when logs were floated along the estuary for milling. The presence of these levees has accelerated the succession of habitat from mudflat to salt marsh, and then from salt marsh to brackish marsh and upland habitat. Specifically, pickleweed appeared to have colonized the mudflat since the logging days and is now being replaced by coastal scrub, rushes, grasses, alders, and willows. It was concluded that excessive erosion from logging and other anthropogenic activities has resulted in major irreversible changes to the estuary.

Keywords: Northern California, tidal marsh, sedimentation

81-09. Schreiber, R.W., (ed.) (1981), "The Biota of the Ballona Region, Los Angeles County," National Oceanic and Atmospheric Association, California Coastal Commission, Oakland, California.

Specific recommendations are made in the report for restoration of Ballona Creek Wetlands within the California Coastal Commission framework. The recommendations include increased tidal flows, preservation of a large area, improved circulation and limitation of human access. Extensive surveys of the area's insects, mammals, birds, herpetofauna, fish, and mollusks are presented. The monitoring methods and apparent health and prospects for the populations are discussed.

Keywords: Southern California, ecology, marsh restoration, monitoring

81-10. Smith, J.P., Jr., and J.O. Sawyer, Jr. (1981), *Keys to the Families and Genera of Vascular Plants in Northwest California*, Mad River Press, Inc., Eureka, California.

Information of the identification of major plant families and genera is provided in the guidebook. The reader is guided through the identification by a list of information. Only a limited number of drawings are used to verify the identification.

Keywords: Northern California, monitoring

81-11. Ustin, S.L., R.W. Pearcy, and D.E. Bayer (1982), "Plant Water Relations in a San Francisco Bay Salt Marsh," *Botanical Gazette*, vol. 143, no. 3, pp. 368-373.

Diurnal and seasonal patterns of plant water potential were measured for three common coastal salt marsh plant species, *Spartina foliosa*, *Scirpus robustus*, and *Salicornia virginica*, that co-occur in the San Pablo Bay marshes. Large seasonal decreases in plant water potential and maximum leaf conductance occurred as soil salinities increased from Spring to Fall. The persistence of the less halophytic *Scirpus* within the *Spartina-Salicornia* ecotone may be due to the ability of *Scirpus* to grow rapidly during the Spring when salinities are low, and to tolerate high salinity later in the year after vegetative growth has ceased.

Keywords: San Francisco Bay, tidal marsh, plant ecology, salinity

81-12. Warrick, S.F. and E.D. Wilcox (1981), "Big River, The Natural History of an Endangered Northern California Estuary," Environmental Field Program Publication No. 6, University of California, Santa Cruz.

Big River, located beside the town of Mendocino, has been identified as the longest and least disturbed estuary in Northern California. Tidal influence can be measured 8.3 miles upriver during the summer months. Habitats within the area include; estuarine, salt marsh, mudflats, freshwater marsh and riparian woodlands. Abundant wildlife is found within the greater estuary area. Increased sedimentation, due to logging of the slopes above the estuary, has led to major changes in the ecosystem. Steep levees exist along the river bed and have effectively cut off much of the salt marsh from daily tidal ebb and flow. Pickleweed areas are drying up and the marsh flats are being invaded by freshwater grasses.

Keywords: Northern California, tidal marsh, freshwater marsh, ecology, hydrodynamics, sedimentation

81-13. Wentz, A.W. (1981), "Wetlands Values and Management," U.S. Fish and Wildlife Service and U.S. Environmental Protection Agency, Washington, D.C.

A very brief discussion of wetlands values and management techniques is provided in the bulletin. Owners of wetlands are encouraged to preserve their land, and management techniques such as waterfowl production, water management, and dredging and diking are briefly described. The emphasis of the publication is on freshwater wetlands.

Keywords: freshwater marsh, maintenance

82-01. Boyd, M.J. (1982), "Salt Marsh Faunas: Colonization and Monitoring," In M.N. Josselyn (ed.), *Wetlands Restoration and Enhancement in California*, pp. 75-79, Report No. T-CSGCP-007, California Sea Grant College Program, California State University, Hayward, California.

Common California wetlands fauna are identified and previous research is reviewed. Re-establishment of faunal populations at a Humboldt Bay restoration site is discussed along with the monitoring techniques utilized.

Keywords: Northern California, tidal marsh, birds, monitoring, insects, fish, invertebrates

82-02. City of Long Beach (1982), "Supplemental Environmental Impact Report - Los Cerritos Wetlands Local Coastal Plan," EIR No. E-9-82, City of Long Beach, Long Beach, California.

The City of Long Beach, a citizens' group, the Coastal Conservancy, and the Department of Fish and Game evaluated four wetland restoration plans for the Los Cerritos Wetlands. Each configuration included tidal wetlands and channels and the construction of a brackish pond with an island for bird nesting and refuge. Circulation would be maintained through a system of culverts, weirs, and slide gates that connect the wetlands to an adjacent river channel. The Coastal Conservancy recommended the two configuration alternatives that had two main separate wetland areas. The other two proposals included one large wetland and two areas that were connected by a long narrow corridor. The Conservancy decided that creating one large wetland was too risky and that the use of a corridor was feasible but untested.

Keywords: Southern California, tidal marsh, marsh restoration, planning

82-03. U.S. Department of the Navy, Naval Facilities Engineering Command (1982), "Compaction, Earthwork and Hydraulic Fills," Foundations and Earth Structures, pp. 54-57, Foundation and Earth Structures, Design Manual 7.2, Alexandria, Virginia.

Practical information and guidelines for using compaction equipment on various soils are included in the publication. Guidance is offered on equipment which can be used for hydraulic fills . No direct applications to marshlands is discussed.

Keywords: dredge spoil, soil, construction

82-04. Diaber, F.C. (1982), *Animals of the Tidal Marsh*, Van Nostrand Reinhold Company, New York.

Chapters on zonation and distribution, interaction with vegetation, food and feeding, and reproduction are contained in the book about tidal marsh animals. The animals discussed in the book include microscopic organisms, worms, molluscs, crustaceans, insects, fish, reptiles, birds, and mammals.

Keywords: mammals, birds, insects, fish, invertebrates, tidal marsh

82-05. Faber, P.M. (1982), "Report on the Current Status of the Muzzi Marsh," Prepared for the Golden Gate Bridge, Highway and Transportation District.

The current condition of the Muzzi Marsh (a Marin County marsh restored in 1976) is evaluated. In 1981, the site was modified to increase tidal flow to all portions of the marsh. Total vegetative cover is now over 90 percent. Cordgrass cover has increased markedly since 1979.

Keywords: San Francisco Bay, soil, marsh restoration, monitoring, plant establishment

82-06. Faber, P.M. (1982), *Common Wetland Plants of Coastal California: A Field Guide for the Layman, Pickleweed Press*, Mill Valley, California.

This book is a field guide for salt, brackish, and freshwater marsh plants. Photocopy reproductions of the plants are used for easy identification.

Keywords: tidal marsh, plant ecology

82-07. Gates, S. (1982), "An Inventory of California Coastal Wetlands with a Potential for Restoration and Enhancement," In M.N. Josselyn (ed.), *Wetlands Restoration and Enhancement in California*, pp. 11-18, Report No. T-CSGCP-007, California Sea Grant College Program, California State University, Hayward, California.

The results of a partially completed survey performed by the State Coastal Conservancy and California Department of Fish and Game are presented. "Potential for restoration" was applied to areas of significant biological importance, areas experiencing critical threat and areas that have projects underway. The need for regional perspectives and management is discussed.

Keywords: maintenance, planning

82-08. Josselyn, M.N. and J. Buchholz (1982), "Summary of Past Wetland Restoration Projects in California," In M.N. Josselyn (ed.), *Wetlands Restoration and Enhancement in California*, pp. 1-10, Report No. T-CSGCP-007, California Sea Grant College Program, California State University, Hayward, California.

An inventory of wetlands restoration projects undertaken within the California coastal zone and the San Francisco Bay is presented. Information about the projects was obtained from permitting agencies and the construction authorities. Restoration work is listed under three different categories; experimental plantings, dike breaching and tidal gate construction, and dike breaching with substrate alteration. Recommendations are made for improvements in the planning process.

Keywords: marsh restoration, planning, inventory

82-09. Josselyn, M.N. and B.F. Atwater (1982), "Physical and Biological Constraints on Man's Use of the Shore Zone of the San Francisco Bay Estuary," In W.J. Kockelman et al. (eds.), *San Francisco Bay: Use and Protection*, pp. 57-84, Pacific Division, American Association for the Advancement of Science, San Francisco, California.

The earthquake hazards associated with development along the shoreline of San Francisco Bay, particularly where wetlands once existed, are discussed in the paper. Also covered in the article are problems associated with levees, wetland/upland boundary disputes, and wetland restoration.

Keywords: legal problems, marsh restoration, permitting

82-10. Knutson, P. L. and W. W. Woodhouse, Jr. (1982), "Pacific Coast Marshes," In R.L. Lewis (ed.), *Creation and Restoration of Coastal Plant Communities*, pp. 111-130, CRC Press, Boca Raton, Florida.

A summary of vegetation establishment along the Pacific Coast is provided in the paper. The focus of the paper on six plant species for introduction efforts: *Spartina foliosa*, *Salicornia spp.* and *Distichlis spicata* for the southern portion of the coast (from Humboldt Bay south); and *Carex Lyngbyei*, *Deschampsia caespitosa*, and *Eleocharis* spp. for the northern portion (from San Francisco Bay north). The transition from southern to northern region is between San Francisco and Humboldt Bays.

Keywords: plant establishment

82-11. Krone, R.B. (1982), "Engineering Wetlands: Circulation, Sedimentation, and Water Quality," In M.N. Josselyn (ed.), *Wetlands Restoration and Enhancement in California*, pp. 53-58, Report No. T-CSGCP-007, California Sea Grant College Program, California State University, Hayward, California.

The natural processes of marsh development are described. Successful restoration projects must reinstitute tidal circulation and sedimentation. Flow directions and velocities can be estimated using a link-node model. Channel design is limited by available dredging equipment and the condition of the marsh soil.

Keywords: sedimentation, soil, hydrodynamics, structures

82-12. Larson, J.S. (1982), "Wetland Value Assesment-State of the Art," In B. Gopal, R.E. Turner, R.G. Wetzel and D.F. Whigham (eds.), *Wetlands: Ecology and Management*, pp. 417-424, National Institute of Ecology and International Scientific Publications, Jaipur, India.

Wetland functions and values include flood control, water quality, fish nursery, productivity, visual cultural values, and wildlife. However, methods for assessing and ranking the relative values of various wetlands are lacking.

Keywords: economic value, tidal marsh, ecology

82-13. Medelssohn, I.A., K.L. McKee, and M.T. Postek (1982), "Sublethal Stresses Controlling *Spartina alterniflora* Productivity," In B. Gopal, R.E. Turner, R.G. Wetzel, and D.F Whigham (eds.), *Wetlands: Ecology and Management*, pp. 223-242, National Institute of Ecology and International Scientific Publications, Jaipur, India.

The factors causing height differences between short-form and tall-form *Spartina alterniflora* are reviewed and investigated. Nitrogen fertilization increases *Spartina* productivity. However, it has been found that ammonia-nitrogen concentrations are significantly higher in the interstitial waters in the short-form areas (further away from the stream at lower elevations than the streamside tall-form). Soil waterlogging occurs in the inland marsh areas where the short-form *Spartina* is located. It is hypothesized that soil waterlogging is responsible for limiting nitrogen utilization by *Spartina*.

Keywords: chemistry and nutrients, tidal marsh, water quality, soil, plant ecology

82-14. Ng, S.Y., J.C. Rudd, and P.D. Dregger (1982), "Embankment Construction Over Swamp Deposits," In C.J. Schexnayder (ed.), *Proceedings of the Specialty Conference on Construction Equipment & Techniques for the Eighties*, pp. 174-185, American Society of Civil Engineers, New York.

Construction on very soft and thick soil deposits is described for environmentally sensitive areas. The goal of the construction technique is to prevent a "mud wave" into sensitive wetlands while placing a more stable embankment over swamp deposits.

Keywords: soil, construction

82-15. Phillips, R.C. (1982), "Seagrass Meadows," In R.L. Lewis (ed.), *Creation and Restoration of Coastal Plant Communities*, pp. 173-201, CRC Press, Boca Raton, Florida.

Provides a summary of transplanting efforts worldwide on a number of different seagrass species, including eelgrass. Includes details on successful and unsuccessful methods and estimated costs for transplanting work.

Keywords: sea grasses, plant establishment

82-16. Race, M.S. and D.R. Christie (1982), "Coastal Zone Development: Mitigation, Marsh Creation and Decision Making," *Environmental Management*, vol. 6, no. 4, pp. 317-328.

Various interpretations of the term "mitigation" are discussed and evaluated. Several marsh creation projects are discussed, as is the direction of current decision making practices in relation to current marsh creation technology.

Keywords: San Francisco Bay, tidal marsh, marsh restoration, planning, maintenance, mitigation banks

82-17. Ray B. Krone & Associates (1982), "Calculated Tides and Currents in the East Third Avenue Widening Marsh Restoration Project," Prepared for the City of San Mateo, San Mateo, California.

The tide heights and currents were calculated for the East Third Avenue Widening Marsh restoration project using a numerical (link-node) model. Based on the results of the computations, it was concluded that the proposed channels and pond system would provide adequate circulation and that the marsh would evolve at the site.

Keywords: San Francisco Bay, hydrodynamics, marsh restoration, tides

82-18. San Francisco Bay Conservation and Development Commission (1982), "Diked Historic Baylands of San Francisco Bay: Findings, Policies, and Maps," San Francisco Bay Conservation and Development Commission, San Francisco, California.

The findings and policies for diked baylands, as adopted on October 21, 1982, are listed and described. The marshes and diked baylands for the entire San Francisco Bay periphery are shown in a set of maps included in the report.

Keywords: San Francisco Bay, planning, inventory

82-19. Shellhammer, H.S., R. Jackson, W. Davilla, A.M. Gilroy, H.T. Harvey, and L. Simons (1982), "Habitat Preferences of Salt Marsh Harvest Mice (*Reithrodontomys raviventris*)," *The Wasmann Journal of Biology*, vol. 40, no. 1-2, pp. 102-114.

Salt marsh harvest mice (*Reithrodontomys raviventris*) use pickleweed (*Salicornia virginica*) as their primary habitat when non-submerged, salt-tolerant, upland vegetation exists nearby and can be used for refuge during extreme high tides. The habitat value of pickleweed increases with depth, density, and the degree of intermixing with fat hen (*Atriplex patula*) and alkali heath (*Frankenia grandifolia*). Salt grass (*Distichlis spicata*) may be valuable in mixtures with pickleweed, but has little habitat value in pure stands. Alkali bulrush provides little habitat value for the salt marsh harvest mouse.

Keywords: San Francisco Bay, mammals, endangered species

82-20. Shute, E.C., Jr. and M.B. Mihaly (1982), "Summary of Powers Exercised by Regulatory Agencies over Diked Historic Baylands and Recommendations," San Francisco Bay Conservation and Development Commission, San Francisco, California.

A summary of the regulatory agencies involved in diked historic San Francisco baylands conservation and development, and the agencies' powers, are included in the report. Recommendations for improved regulatory and planning processes are also given.

Keywords: San Francisco Bay, planning, permitting

82-21. Sorensen, J. (1982), "Towards an Overall Strategy in Designing Wetlands Restoration," In M.N. Josselyn (ed.), *Wetlands Restoration and Enhancement in California*, pp. 84-91, Report No. T-CSGCP-007, California Sea Grant College Program, California State University, Hayward, California.

The various stages involved in designing a restoration program are outlined. A flow diagram for design and implementation is presented that applies to wetland areas that are privately owned or that will need private funds to complete restoration.

Keywords: marsh restoration, planning

82-22. California State Coastal Conservancy (1982), "Regional Wetland Restoration Study: Los Angeles and Orange Counties Final Draft Report," California Coastal Conservancy, Oakland, California.

Wetlands in Los Angeles and Orange Counties were reduced in area by 82 percent from 1894 to 1982. Freshwater marshes were significantly destroyed. Of the total freshwater marsh area remaining, 92 percent exist in the Upper Newport Bay area. Restoration goals for Los

Angeles and Orange Counties include; creation of freshwater marshes, provision of habitat diversity to support many different species, creation of a chain of habitats to facilitate travel of migratory birds, and educational access. The State Coastal Conservancy recommends specific design considerations and criteria to follow in choosing restoration sites. The wetlands of the region are described according to habitats, land use, water quantity, water quality, and land ownership. Acreages and bird use of selected wetlands are included.

Keywords: Southern California, tidal marsh, freshwater marsh, marsh restoration, planning, inventory

82-23. Teal, J.M., A. Giblin, and I. Valiela (1982), "The Fate of Pollutants in American Salt Marshes," In B. Gopal, R.E. Turner, R.G. Wetzel and D.F. Whigham (eds.), *Wetlands: Ecology and Management*, pp. 357-366, National Institute of Ecology and International Scientific Publications, Jaipur, India.

A sludge-based fertilizer was applied to a New England salt marsh for 10 years. Sludge can contain a wide range of heavy metals, halogenated hydrocarbons, and hydrocarbons. Heavy metals such as iron, lead, and mercury tend to bind to sediments, remain close to the source of contamination, and concentrate over time. Other metals such as cadmium, zinc and chromium tend to pass through wetlands relatively rapidly because they form soluble complexes in sea water. In the 10 year study there were two instances of deleterius effects of organic compounds, which resulted in reduced populations of certain invertebrates. However, very little is known about the effects of organic compounds on marsh systems. The addition of the sludge-based fertilizer increased above-ground production.

Keywords: invertebrates, tidal marsh, water quality, wastewater treatment

82-24. Valiela, I., B.L. Howes, R.W. Howarth, A. Giblin, K. Foreman, J.M. Teal, and J.E. Hobbie (1982), "Regulation of Primary Production and Decomposition in a Salt Marsh Ecosystem," In B. Gopal, R.E. Turner, R.G. Wetzel and D.F. Whigham (eds.), *Wetlands: Ecology and Management*, pp. 151-168, National Institute of Ecology and International Scientific Publications, Jaipur, India.

Salt marsh productivity is primarily limited by nitrogen availability and secondarily limited by phosphorous availability. The chemically reduced condition of marsh sediments restricts nitrogen uptake in spite of the high concentration of inorganic nitrogen in interstitial water. The decay of marsh vegetation initially involves the leaching of soluble organic material followed by a complex process involving microorganisms and is affected by the time of immersion in tidal water, internal carbon/nitrogen ratios, and action of detritus feeders. Most marsh production occurs below-ground; where denitrifiers, fermenters and primary sulfate reducers consume all of the below-ground production.

Keywords: chemistry and nutrients, tidal marsh, water quality

82-25. Whigham, D.F. (1982), "Using Freshwater Wetlands for Wastewater Management in North America," In B. Gopal, R.E. Turner, R.G. Wetzel and D.F. Whigham (eds.), *Wetlands: Ecology and Management*, pp. 507-514, National Institute of Ecology and International Scientific Publications, Jaipur, India.

Short-term treatment of wastewater has been achieved using natural and artificial wetlands, but the long-term effects of wastewater treatment with wetlands are relatively unknown. Natural peat-based wetlands have been successful for long-term treatment, but artificial wetlands appear to have the most potential. The three most important factors in determining the usefulness of a wetland for wastewater treatment are the hydrologic characteristics (especially contact time), the type of substrate, the ability of macrophytes to utilize nutrients applied in wastewater, and seasonality.

Keywords: freshwater marsh, wastewater treatment

82-26. Whigham, D.F., J. O'Neill, and M. McWethy (1982), "Ecological Implications of Manipulating Coastal Wetlands for Purposes of Mosquito Control," In B. Gopal, R.E. Turner, R.G. Wetzel and D.F. Whigham (eds.), *Wetlands: Ecology and Management*, pp. 459-476, National Institute of Ecology and International Scientific Publications, Jaipur, India.

A form of Mosquito control that is being used on the East Coast is "open marsh water management", which consists primarily of ditching. The effects of ditching include lowered water tables, vegetational changes and increased tissue nitrogen and phosphorous concentrations. Primary production also increased along the ditches and it is hypothesized that the increased production is a result of aerated soils due to the lowered water table.

Keywords: insects, water quality, maintenance, mosquito control

82-27. Zedler, J.B. (1982), "The Ecology of Southern California Coastal Salt Marshes: A Community Profile," FWS/OBS-81/54, Biological Services Program, U.S. Fish and Wildlife Service,Washington, D.C.

The geological history, tidal circulation, climate, salinity, flora and fauna of the coastal marshes of Southern California are described. Ecological problems are identified and specific recommendations made for restoration and management.

Keywords: Southern California, tidal marsh, ecology, maintenance

82-28. Zedler, J.B., M.N. Josselyn, and C.P. Onuf (1982), "Restoration Techniques, Research and Monitoring: Vegetation," In M.N. Josselyn (ed.), *Wetlands Restoration and Enhancement in California*, pp. 63-72, Report No. T-CSGCP-007, California Sea Grant College Program, California State University, Hayward, California.

Restoration objectives and techniques are discussed in the article. Comparisons of the physiography, flora, and fauna of the different California coastal wetland ecoregions are made. Procedures are listed for use in establishing vegetation and to monitor success of the projects.

Keywords: marsh restoration, monitoring, plant establishment

82-29. Zentner, J. (1982), "Development of Regional Wetland Restoration Goals: Coastal Wetlands," In M.N. Josselyn (ed.), *Wetlands Restoration and Enhancement in California*, pp. 23-31, Report No. T-CSGCP-007, California Sea Grant College Program, California State University, Hayward, California.

General restoration goals and wetland values are defined and then narrowed down for the coast of California. The emphasis is placed on diversity of plant and animal habitats. The three coastal wetland regions of California are described and specific restoration goals are assigned to each area.

Keywords: planning

83-01. Adamus, P.R. and L.T. Stockwell (1983), "A Method for Wetland Functional Assessment, Volume I, Critical Review and Evaluation Concepts," Report No. FHWA-1P-82-23, Federal Highway Administration, Washington, D.C.

Wetland functions and values are defined in volume I for subsequent use in WET 2.0. All wetland types of the conterminous U.S. are included and ranked for each function. Highway impacts on wetlands and possible mitigation methods, including enhancement and restoration, are discussed briefly.

Keywords: economic value, tidal marsh, freshwater marsh, water quality, hydrodynamics, sedimentation, erosion control

83-02. Allen, H.H. and J.W. Webb (1983), "Erosion Control with Saltmarsh Vegetation," In O.T. Magoon and H. Converse (eds.), *Poceedings of the Third Symposium on Coastal and Ocean Management, Coastal Zone '83*, pp. 735-748, American Society of Civil Engineers, New York.

A saltmarsh was established in a moderately high wave-energy area on a dredged material island in Mobile Bay, Alabama. Smooth cordgrass (*Spartina alterniflora*) sprigs were mechanically transplanted into the area. A floating tire breakwater arrangement was also used to lessen the effects of the waves. It was found that the breakwater greatly increased plant survival.

Keywords: erosion control, plant establishment, dredge spoil, structures

83-03. Balling, S.S. and V.H. Resh (1983), "The Influence of Mosquito Control Recirculation Ditches on Plant Biomass, Production and Composition in Two San Francisco Bay Salt Marshes," *Estuarine Coastal and Shelf Science*, vol. 16, pp. 151-161.

Vegetation of two San Francisco Bay tidal marshes was examined to determine the effects of recirculation ditches designed to eliminate mosquito-breeding. In Petaluma Marsh, *Salicornia virginica* growth rates were higher near ditches than in the open marsh. In the less saline Suisun Marsh there was a displacement of the more salt tolerant *S. virginica* by the less salt tolerant *Juncus balticus*, and a significantly greater number of species near the ditches.

Results in both marshes are correlated with low groundwater salinities near ditches, which occurs in response to increased tidal flushing.

Keywords: San Francisco Bay, tidal marsh, hydrodynamics, mosquito control, plant establishment, plant ecology, maintenance

83-04. Bella, D.A. (1983), "Hydrogen Sulfide Gas," In J.R. Clark (ed.), *Coastal Ecosystem Management*, pp. 643-644, Robert F. Krieger Publishing Co., Malabar, Florida.

Sulfides can be released into the overlying waters and the atmosphere from bottom deposits in wetlands. The presence of sulfides is of concern because they can be toxic to some organisms, lower dissolved oxygen concentrations, and contribute to air pollution. Sulfides are produced in the anaerobic layer of marsh soil and migrate to the surface if concentrations are high enough or if the substrate is disturbed by dredging. Circulation should be improved and waste discharge limited to prevent sulfide emissions.

Keywords: chemistry and nutrients, water quality, soil, hydrodynamics

83-05. Bockrath, J.T. and D.F. Polis (1983), "Tidemark Boundaries," In J.R. Clark (ed.), *Coastal Ecosystem Management*, pp. 738-740, Robert F. Krieger Publishing Co., Malabar, Florida.

Many state governments declare land below mean high water (MHW) to be public property. The tidal boundary is difficult to measure as it can be influenced by wind, wave run-up, climate changes and currents. The courts have required an 18.6 year average of tidal measurements, but most stations have only a few days of data. The State of California considers the high tide level to be the limit reached by neap tides.

Keywords: legal problems, hydrodynamics, regulations

83-06. California Department of Fish and Game (1983), "A Plan for Protecting, Enhancing and Increasing California's Wetlands for Waterfowl," California Department of Fish and Game, Sacramento, California.

More than 90 percent of California's historical wetlands (fresh and saltwater) have either been converted or destroyed and seventy percent of California's coastal wetlands have been lost due to dredging and filling. Only 5 percent of Pacific Flyway waterfowl utilize coastal wetlands, but some species use the coast almost exclusively. Senate Concurrent Resolution 28 authorized the Department of Fish and Game to prepare a plan to reverse the trend of wetland conversion, improve wetland value, and increase wetlands by 50 percent. The Department's plan includes tax incentives for landowners who preserve or enhance wetlands; funding to acquire and manage wetlands; and the utilization of wastewater, agricultural drainage water, and Central Valley Project water to create and restore wetlands.

Keywords: economic value, tidal marsh, freshwater marsh, planning

83-07. Clancy, E.P. (1983), "Tides," In J.R. Clark (ed.), *Coastal Ecosystem Management*, pp. 735-738, Robert F. Krieger Publishing Co., Malabar, Florida.

Tidal forces result from an imbalance between centrifugal and gravitational forces on the surface of the earth. The height of a tide is determined by the position of the moon and sun. Tides contribute to the erosion of shorelines, change bottom configurations, determine currents in bays and estuaries, and contribute to the formation of sandbars. Changes in salinity due to mixing with freshwater and flushing of pollutants are additional results of tidal action.

Keywords: tides, salinity, hydrodynamics

83-08. Clark, J.R. (ed.) (1983), *Coastal Ecosystem Management*, Robert F. Krieger Publishing Co., Malabar, Florida.

Ecological background is provided to facilitate the management of coastal areas. Specific guidelines for the protection of the areas are presented along with a management framework. The appendixes contain the text of applicable federal regulations and technical information on soil types, water quality criteria, and wastewater treatment characteristics.

Keywords: ecology, hydrodynamics, dredging, maintenance, regulations

83-09. Dennis, N.B. and M.L. Marcus (1983), "Status and Trends of California Wetlands," ESA/Madrone, Novato, California.

The history, resources, uses, and abuses of California's wetlands are detailed in the report. The organizations and agencies that are involved with wetland conservation and development are listed and described. The history and current status of the wetlands of California are described in detail and are broken down into regions.

Keywords: San Francisco Bay, Southern California, Northern California, Central California, ecology, permitting

83-10. Gallagher, J.L. (1983), "Zonation of Wetlands Vegetation," In J.R. Clark (ed.), *Coastal Ecosystem Management*, pp. 752-758, Robert F. Krieger Publishing Co., Malabar, Florida.

Salt marsh vegetation is found in zones that are determined largely by tidal influence. The tides directly affect the distribution of plants by changing the salinity, by making nutrients available, and by the removal of wastes from the marsh. Other determining factors include soil texture, aeration of the root zone, and freshwater inflow. It may be possible to utilize the vegetation zone to delineate boundaries between public and private property.

Keywords: plant ecology, regulations

83-11. Grenfell, W.E., Jr. and W.F. Laudenslayer, Jr. (eds.) (1983), "The Distribution of California Birds," California Wildlife/Habitat Relationships Program, Publication No. 4, California Department of Fish and Game, Sacramento, California, and U.S.D.A. Forest Service, San Francisco, California.

Distribution maps for 340 species of California birds are included in the report. Summer and Winter ranges are mapped, but the maps do not include information on abundance.

Keywords: birds

83-12. Gunter, G. (1983), "Salinity," In J.R. Clark (ed.), *Coastal Ecosystem Management*, pp. 694-697, Robert F. Krieger Publishing Co., Malabar, Florida.

The salts in seawater appear to be a result of vulcanism. Salt concentration is approximately 35 ppt by weight, and five main salts makeup 99.7 percent of the total. Salinity affects the movement of water by changing its specific gravity. The osmotic properties of seawater determine the presence of different life forms.

Keywords: salinity

83-13. Harvey, H.T., P.B. Williams, Madrone Associates, and San Francisco Bay Conservation and Development Commission (1983), "Guidelines for Enhancement and Restoration of Diked Historic Baylands," San Francisco Bay Conservation and Development Commission, San Francisco, California.

The regional habitat needs for San Francisco Bay are discussed. Enhancement and restoration procedures are listed and described and include hydraulic design (tidal elevations, marsh topography, topographic modifications, outlet structures, drainage, circulation, sedimentation, and erosion), vegetation establishment (substrate, topography, species requirements, endangered species, exotic plants, and upland and transition zone enhancement) and follow-up management. Also included is a section on stormwater and wastewater treatment using marshes.

Keywords: San Francisco Bay, hydrodynamics, marsh restoration, plant establishment, maintenance, wastewater treatment

83-14. Josselyn, M.N. (1983), "The Ecology of San Francisco Bay Tidal Marshes: A Community Profile," FWS/OBS-83-23, Division of Biological Services, U.S. Fish and Wildlife Service, Washington, D.C.

A detailed description of San Francisco Bay tidal marshes is given. Topics include past and present descriptions of Bay marshes, geophysical attributes of San Francisco Bay and its tidal marshes, plant composition and zonation in tidal marshes, animal inhabitants of tidal marshes, community metabolism of Bay tidal marshes and management of tidal marshes and their restoration.

Keywords: San Francisco Bay, tidal marsh, ecology, marsh restoration

83-15. Knutson, P.L. and W. W. Woodhouse (1983), "Shore Stabilization With Salt Marsh Vegetation," U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Virginia.

Guidelines for establishing coastal salt marsh vegetation for erosion control are provided in the report. Specific establishment techniques for certain plant species are presented.

Guidelines for evaluating the suitability of a site based on soil characteristics and wave climate are also provided.

Keywords: soil, plant establishment, erosion control

83-16. Kobriger, N.P., T.V. Dupuis, W.A. Kreutzberger, F. Stearns, G. Guntenspergen, and J.R. Keough (1983), "Guidelines for the Management of Highway Runoff on Wetlands," Transportation Research Board, National Research Council, Washington, D.C.

Several pollutants, particularly heavy metals, are contained in highway runoff. Wetlands can be used to remove many pollutants depending on their treatment capacity and potential impacts. It is recommended that man-made wetlands be used for highway runoff treatment as the pollutants may alter a natural marsh. Maintenance and monitoring of wetlands is also discussed, as are modeling techniques and highway construction considerations.

Keywords: tidal marsh, marsh restoration, planning, construction, maintenance, wastewater treatment

83-17. LaRoe, E.T. (1983), "Dredging-Ecological Impacts," In J.R. Clark (ed.), *Coastal Ecosystem Management*, pp. 610-613, Robert F. Krieger Publishing Co., Malabar, Florida.

The ecological impacts of dredging and filling are described. Particular emphasis is given to turbidity and siltation which can smother benthic organisms and reduce photosynthetic activity. During the planning process, consideration must be given to the dredging depth and the subsequent changes that will be made in the circulation pattern.

Keywords: water quality, sedimentation, dredging

83-18. Long, S.P. and C.F. Mason (1983), *Salt Marsh Ecology*, Blackie and Son Limited, Bishopbriggs, Glasgow, United Kingdom.

A comprehensive overview of salt marshes is provided in the book. The primary source of material for this text is salt marshes in England and the Eastern United States. However, information is presented on numerous other marsh systems around the world, including California. Although many of the conclusions that are presented were made with species other than from California, the same genus' are represented and many chemical and physical process descriptions are more completely described than for California systems.

Keywords: chemistry and nutrients, tidal marsh, ecology, water quality, salinity, soil, geomorphology, monitoring

83-19. Madrone Associates, Philip Williams and Associates, and San Francisco Bay Conservation and Development Commission (1983), "Ecological Values of Diked Historic Baylands," San Francisco Bay Conservation and Development Commission, San Francisco, California.

The ecological values (plant distribution and animal utilization) of the diked historic baylands of San Francisco Bay are described in detail. The alterations that have been made to the former marsh areas are also described thoroughly.

Keywords: San Francisco Bay, ecology

83-20. Reimhold, R.J. (1983), "Constructive Use of Dredge Spoil," In J.R. Clark (ed.), *Coastal Ecosystem Management*, pp. 589-592, Robert F. Krieger Publishing Co., Malabar, Florida.

The use of dredge spoil to create artificial habitats and wetlands is emphasized over open-water disposal or land disposal. The deposition of clay can encourage the establishment of benthic organisms while placement of coarse material can encourage shellfish. The construction of islands has produced some problems with organisms establishing themselves before restoration work was completed. The loss of previous habitat should be balanced with the expected benefits.

Keywords: dredge spoil, marsh restoration, dredging

83-21. Resh, V.H. and S.S. Balling (1983), "Ecological Impact of Mosquito Control Recirculation Ditches on San Francisco Bay Marshlands: Study Conclusions and Management Recommendations," In *Proceedings and Papers of the Fifty-first Annual Conference of the California Mosquito and Vector Control Association, Inc.*, pp. 49-53, California Mosquito and Vector Control Association, Inc., Sacramento, California.

As a result of the study, it was determined that mosquito ditches have negligible effects on the ecology of *Salicornia*, terrestrial anthropods, fish, and marsh sparrows. Detrimental effects were discovered for aquatic invertebrate diversity and no solutions were provided to mitigate the problem. The impacts of ditching on *Spartina* and several animal inhabitants of the marsh were not discussed. Three positive and very useful recommendations were made in the report and include: (1) ditching should only be done on ponds which have been identified to produce mosquitos, (2) ditching should not be done in porous soils because the water level may be lowered and upland plants may invade the marsh, and (3) ditches should be made as shallow as possible. Of significant importance is the discussion of the "mosquito production threshold". Guidelines for pond elevations and recommendations for areal requirements of ponds are given in the report.

Keywords: San Francisco Bay, soil, hydrodynamics, planning, construction, maintenance, mosquito control

83-22. Robbins, C.S., B. Brown, and H.S. Zim (1983), *A Guide to Field Identification - Birds of North America*, Western Publishing Company, Inc., Racine, Wisconsin.

The identification of all birds that nest in North America, that are regular vagrants, and that may be accidentals from other continents is covered in the book. Each species is identified by family order and described in terms of plumage, song, silhouette, and range.

Keywords: birds, monitoring

83-23. Schweitzer, J.P. (1983), "Estuarine Circulation," In J.R. Clark (ed.), *Coastal Ecosystem Management*, pp. 614-622, Robert F. Krieger Publishing Co., Malabar, Florida.

A classification system based on circulation and salinity is presented. The system can be applied to coastal plains estuaries, which is the most prevalent type. The degree of stratification between fresh and salt water defines the particular classification type which ranges from highly stratified to cross sectionally homogeneous. The prevailing conditions and mechanisms that determine the amount of stratification are described.

Keywords: classification, salinity, hydrodynamics

83-24. Seliskar, D.M and J.L. Gallagher (1983), "The Ecology of Tidal Marshes of the Pacific Northwest Coast: A Community Profile," FWS/OBS-83/32, U.S. Fish and Wildlife Service, Washington, D.C.

The ecology of tidal marshes in Oregon and Washington is described in detail in the report. The report includes chapters on the physical and chemical environment, marsh distribution, biotic communities, ecological interactions, and management.

Keywords: Northern California, chemistry and nutrients, tidal marsh, ecology, lagoon, freshwater marsh

83-25. Simenstad, C.A. (1983), "The Ecology of Estuarine Channels of the Pacific Northwest Coast: A Community Profile," FWS/OBS-83/05, U.S. Fish and Wildlife Service, Washington, D.C.

The ecology of estuarine channels located along the Northern California, Oregon, and Washington coasts is discussed in detail. The report includes chapters on physical description, primary production, detritus processing, invertebrates, fish, birds, mammals, and trophic and community ecology.

Keywords: Northern California, chemistry and nutrients, tidal marsh, ecology, geomorphology

83-26. Smith, D.D. (1983), "A Practical Evaluative Procedure for the Design of Coastal Wetland Restoration Projects," In O.T. Magoon and H. Converse (eds.), *Proceedings of the Third Symposium on Coastal and Ocean Management (Coastal Zone '83)*, pp. 1477-1487, American Society of Civil Engineers, New York.

A multi-step evaluative procedure that facilitates assessment of biological benefits, technical feasibility, and cost of alternative designs to select the optimum restoration design is summarized in the paper.

Keywords: economic value, marsh restoration, planning

83-27. Sorensen, J. and S. Gates (1983), "New Directions in Restoration of Coastal Wetlands," In O.T. Magoon and H. Converse (eds.), *Proceedings of the Third Symposium on Coastal and Ocean Management (Coastal Zone '83)*, pp. 1427-1443, American Society of Civil Engineers, New York.

Three aspects of wetland design are discussed in the paper. These include obtaining a regional perspective, co-operative arrangements with the private sector, and design problems associated with substantial modifications of the site. The analysis is based on case histories of Southern California wetlands restoration projects and studies, but should be useful for other coastal areas.

Keywords: marsh restoration, planning

83-28. Stumpf, R.P. (1983), "The Process of Sedimentation on the Surface of a Salt Marsh," *Estuarine, Coastal and Shelf Science*, vol. 17, pp. 495-508.

Holland Glade Marsh in Delaware was investigated to identify the processes involved with sedimentation on the marsh surface. Water velocity and sediment concentration were periodically sampled at different locations throughout the marsh along with sedimentation rates and grain size distribution of the bed. Analysis of core sample data indicated that the average annual sedimentation rate matched the local sea level rise. However, the amount of sedimentation provided by the tidal cycles could not account for the observed sedimentation rate. A shortage of sediment in the water column was especially apparent in the high marsh. Measurements during and after 0.5 to 1 year storm events revealed that the sedimentation rate was primarily controlled by large storms and not by periodic tidal cycles. A second test was conducted to determine why very fine particles which would not normally settle in the still water were deposited on the marsh surface. The very fine particles were at smaller concentrations in the high marsh than at the marsh inlet and it was theorized that either filter feeding mussels were actively removing the particles or they were being removed by plants. Using known feeding information, it was calculated that about 5 percent of the particles could have been removed by the mussels. Experiments with *Spartina* led the researchers to determine that about 50 percent of the fines were captured and held by the plant stems. Death and collapse of the stems transport the fines to the marsh surface. The remaining 45 percent of the fine sediments were believed to have also been caught by *Spartina* and their loss in the estimation was attributed to experimental error. It was further speculated and observed that grazing gastropods could discharge fecal pellets which transport some fines to the marsh surface along with rainwater.

Keywords: sedimentation, hydrodynamics, monitoring

83-29. Williams, P.B. and H.T. Harvey (1983), "California Coastal Salt Marsh Restoration Design," In O.T. Magoon and H. Converse (eds.), *Proceedings of the Third Symposium on Coastal and Ocean Management (Coastal Zone '83)*, pp. 1444-1456, American Society of Civil Engineers, New York.

Biologic, hydrologic, and engineering constraints on designing and implementing salt marsh restoration and enhancement projects along the coast and estuaries of California are described in the paper.

Keywords: soil, hydrodynamics, sedimentation, marsh restoration

84-01. Allen, H.H., J.W. Webb, and S.O. Shirley (1984), "Wetlands Development in Moderate Wave-Energy Climates," In *Proceedings of the Conference Dredging '84*, Waterway, Port, Coastal and Ocean Division, American Society of Civil Engineers, Clearwater Beach, Florida.

The status of marsh plantings from 1981 to 1983 in Louisiana on dredge spoil islands is reviewed in the paper. The performance of plant rolls, mats, tires, and floating tire breakwaters are compared and contrasted with each other.

Keywords: dredge spoil, erosion control, plant establishment, structures

84-02. California State Coastal Conservancy (1984), "A Program for Restoring the Environment of Tomales Bay," California State Coastal Conservancy, Oakland, California.

Cattle grazing, farming, logging, and residential development have created erosion and sedimentation problems that have changed, and continue to change, Tomales Bay, its surrounding marshes, and its watershed. Several restoration projects are described briefly and future enhancement, restoration and research projects are outlined.

Keywords: Central California, tidal marsh, freshwater marsh, erosion control, sedimentation, marsh restoration

84-03 Faber, P.M. (1984), "Report on the Current Status of the Muzzi Marsh: Report #4," Prepared for the Golden Gate Bridge, Highway and Transportation District.

The current condition of the Muzzi Marsh (a Marin County marsh restored in 1976) is evaluated. While the entire marsh is briefly examined, the focus of the report is on changes in the marsh resulting from site modifications (channel work) performed in 1981. the site continues to improve (more vegetation, animal species, etc.).

Keywords: San Francisco Bay, soil, sedimentation, marsh restoration, plant establishment, monitoring

84-04. Gearheart, R.A. and D.M. Hill (1984), "Butcher's Slough Wetlands Restoration Project, Final Environmental Impact Report," Prepared for the City of Arcata, California.

The proposed project entails the restoration of swamp habitat to freshwater and brackish water wetlands. Butcher's Slough would be realigned to follow a more historic course. Gradual slopes would be built along the slough's banks to allow establishment of estuarine species. The estuary and salt marsh would surround a large freshwater pond with four islands. Dikes would be built to protect the freshwater pond. A sediment trap would be installed at the north end of the project on Jolly Giant Creek to prevent filling of the estuary. Estimated sediment removal is 200 cubic yards of sediment per year. A total of 4 acres of open water, 8.3 acres of brackish marsh and 3 acres of freshwater marsh would be restored.

Keywords: Northern California, tidal marsh, freshwater marsh, marsh restoration, sedimentation

84-05. Hopkins, D.R. and V.T. Parker (1984), "A Study of the Seed Bank of a Salt Marsh in Northern San Francisco Bay," *American Journal of Botany*, vol. 71, no.3, pp. 348-355.

Abundance, species composition, and distribution of buried seeds in China Camp Marsh (Northern San Francisco Bay) were studied by collecting soil samples and observing seedling emergence in the greenhouse. *Salicornia virginica* dominated the seed bank, while most other marsh species were present in the seed bank, but low in numbers. *Spartina foliosa* was absent from the seed bank. A significant correlation was found between highest species diversity and proximity to channels.

Keywords: San Francisco Bay, plant establishment, plant ecology

84-06. Josselyn, M.N. and J. Buchholz (1984), "Marsh Design in San Francisco Bay: A Guide to Design and Planning," Technical Report #3, Tiburon Center for Environmental Studies, San Francisco State University, Tiburon, California.

The marsh guide includes chapters on the extent of marshes in Marin County, case histories of three salt marsh restoration projects in Marin County, shoreline erosion and sedimentation in marsh restoration, habitat design objectives, and monitoring of restoration projects.

Keywords: San Francisco Bay, tidal marsh, marsh restoration, erosion control, sedimentation, monitoring, plant establishment

84-07. Leopold, L.B., L.M. Collins, and M. Inbar (1984), "Channel and Flow Relationships in Tidal Salt Marsh Wetlands," Water Resources Center Project UCAL-WRC-W-629, California Water Resources Center, University of California, Davis.

A study of the water surface profiles in portions of Petaluma Marsh is presented in the report.

Keywords: San Francisco Bay, tidal marsh, hydrodynamics

84-08. Office of Technology Assessment (1984), "Wetlands: Their Use and Regulation," OTA-O-206, Congress of the United States, Washington, D.C.

Different types of wetlands and their uses are described. Quantitative data are given on wetland acreage and the trends in development. Present legislation and government policy affecting the preservation and reclamation of wetlands is discussed. The increased use of mitigation is examined and compared to a policy of preservation.

Keywords: inventory, planning, regulations, permitting

84-09. Philipupillai, J. and I.A. Ungar (1984), "The Effects of Seed Dimorphism on the Germination and Survival of *Salicornia europaea* L. Populations," *American Journal of Botany*, vol. 71, pp. 542-549.

Salicornia europaea produces small and large seeds. Large seeds germinate in low salinity environments in the spring. Small seeds are more dormant under high salinity conditions and require light and stratification to germinate.

Keywords: plant establishment

84-10. Shellhammer, H.S., T.E. Harvey, M.D. Knudsen, and P. Sorenson (1984), "Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan," U.S. Fish and Wildlife Service, Portland, Oregon.

A recovery plan for the salt marsh harvest mouse and the California clapper rail is described in the report. Also included in the report is some historical information on San Francisco Bay marshes and detailed information about the salt marsh harvest mouse and the California clapper rail.

Keywords: San Francisco Bay, endangered species, birds, mammals

84-11. Springer, P.F. and J.O. Sawyer, Jr. (1984), "Response of Vegetation and Vertebrates other than Fish to a Tidal Marsh Restoration Project in Humboldt Bay," Humboldt State University Foundation, Arcata, California.

An abandoned log pond in Eureka, California was chosen as an off-site mitigation area for the loss of saltmarsh and mudflats at the Woodley Island marina in Humboldt Bay. The marsh was restored by breaching a dike and allowing tidal waters to periodically flood a portion of the log pond. Soil, water quality, vegetation, birds, and mammals were studied to determine the effects of the restoration efforts. A nearby undisturbed marsh was used as a control for comparison purposes.

Keywords: Northern California, tidal marsh, monitoring, birds, mammals, plant ecology

84-12. U.S. Army Corps of Engineers (1984), "San Francisco Bay Tidal Stage Versus Frequency Study," U.S. Army Corps of Engineers, San Francisco District, San Francisco, California.

The results of a 100-year high tide study performed for San Francisco Bay are provided in the report.

Keywords: San Francisco Bay, tides

84-13. U.S. Army Corps of Engineers (1984), "Shore Protection Manual, Volumes I and II," Waterways Experiment Station, Vicksburg, Mississippi.

A comprehensive manual on coastal engineering problems and practices. The effects of waves, tides, and other coastal phenomena on natural and man-made coastal shores are presented. Design material is provided for structures in the coastal environment.

Keywords: hydrodynamics, geomorphology, sedimentation, erosion control, structures

84-14. Zedler, J.B. (1984), "Salt Marsh Restoration, A Guidebook for Southern California," Report No. T-CSGCP-009, California Sea Grant College Program, University of California, La Jolla, California.

A planning and design process for wetlands restoration is presented in the report. The plan emphasizes the need for regional perspective and cooperation between planning officials and the scientific community. Specific planting techniques and the results of experimental plantings of cordgrass are outlined.

Keywords: Southern California, marsh restoration, planning, plant establishment

84-15. Zedler, J.B. and W.P. Magdych (1984), "Freshwater Release and Southern California Coastal Wetlands: Management Plan for the Beneficial Use of Treated Wastewater in the Tijuana River and San Diego River Estuaries," San Diego Association of Governments, San Diego, California.

Proposals have been presented to the San Diego Regional Water Quality Control Board to discharge treated wastewater effluent to the San Diego River and Tijuana River Estuaries. The release of freshwater into the estuaries can be beneficial if managed properly. The amount of freshwater and the timing of its release must be controlled. Maximum quantities for each estuary have been determined through salinity models. Discharging amounts over the limits could reduce salinities to levels that would allow favorable conditions for the establishment of freshwater plant species. The freshwater should be impounded and released at the ebb of high tide. At high tide the prism is large enough to dilute the effects of freshwater and reduce the stress it may place on salt marsh organisms. The wastewater could also be used to improve degraded areas of marsh through watering to reduce soil salinity and sand fluidization to remove flow barriers.

Keywords: Southern California, salinity, marsh restoration

84-16. Zedler, J.B., R. Koenigs, and W.P. Magdych (1984), "Freshwater Release and Southern California Coastal Wetlands, Technical Report 1: Streamflow for the San Diego and Tijuana Rivers,", San Diego Association of Governments, San Diego, California.

Streamflow for the San Diego and Tijuana Rivers was characterized by distribution, duration and quantity of rainfall; releases from upstream reservoirs; and potential releases from water reclamation plants. The tidal prisms for the San Diego River and Tijuana River Estuaries were calculated based on cross sectional area of estuary entrances and on idealized channel shapes. Good correlation between the two methods was noted for a reduction in tidal range of one foot between the open ocean and the estuary. The effect of the determined freshwater flow on salinity was analyzed with a computer model. The calculated values were close to measured values at low tide. High tide values were not as accurate. The loss of accuracy is believed to be caused by the tidal lag. The model did not include the effects of stratification, precipitation or sand bar formation.

Keywords: Southern California, salinity, hydrodynamics

84-17. Zedler, J.B., R. Koenigs, and W.P. Magdych (1984), "Freshwater Release and Southern California Wetlands, Technical Report 2: Review of Salinity Effects and Predictions of Estuarine Responses to Lowered Salinity," San Diego Association of Governments, San Diego, California.

The tolerance of salt marsh species to lower salinity was determined through a literature review and experimentation. Plant growth was observed to increase with decreasing concentrations of salt, but there appeared to be a limiting point for some plant species, specifically pickleweed. Most salt marsh plant species have lower freshwater tolerance during seed germination than during other life stages. The main problem with a reduction in salinity for plants is that the environment becomes more habitable for freshwater species which may out-compete saltwater species. Algal productivity is directly reduced as salinity decreases. Additional productivity effects result from reduced light penetration to algal mats after invasion of freshwater plants or the increased growth of halophytes. An increase in mortality of benthic invertebrates and fish has been observed after flooding of marshes. It is difficult to separate out the individual effects of changes in temperature, turbidity, sedimentation and salinity. Invertebrates appear to be particularly sensitive to reductions in salinity.

Keywords: Southern California, invertebrates, tidal marsh, salinity

85-01. Arnold, C.J. (1985), "The Arcata Marshes: A Case Study in Wetland Restoration," In O.T. Magoon et al. (eds.), *Proceedings of the Fourth Symposium on Coastal and Ocean Management (Coastal Zone '85)*, pp. 562-577, American Society of Civil Engineers, New York.

The site history, restoration goals, and success of three Arcata marsh restoration projects are discussed in the paper. The marsh restoration projects include the Arcata Marsh and Wildlife Sanctuary, the Arcata Salt Marsh, and Butcher's Slough wetland enhancement.

Keywords: Northern California, marsh restoration, planning

85-02. Dedrick, K.G. (1985), "Modern and Historic Mapping of Tidal Marshlands of San Francisco Bay, California," In O.T. Magoon et al. (eds.), *Proceedings of the 4th Symposium on Coastal and Ocean Management (Coastal Zone '85)*, pp. 2353-2373, American Society of Civil Engineers, New York.

Several maps (made in 1857, 1897, 1931, 1952, and 1984) of two South San Francisco Bay tidal marshland areas were compared to determine historic mapping accuracy, and marsh erosion and accretion rates. It is concluded that the earliest 1857 maps showed considerable verifiable detail, but ignored the extensive upper reaches and tributary waterways seen in 1984 maps.

Keywords: San Francisco Bay, geomorphology, monitoring, inventory

85-03. Drabelle, D. (1985), "Life on the Edge: The Battle for the East Bay's Endangered Wetlands," *Express*, vol. 7, no. 48, pp. 1, 13-17.

The battle between developers and environmentalists, in regard to developing diked historic baylands in San Francisco Bay, is discussed. The Army Corps of Engineers' permitting process and its shortcomings are also described.

Keywords: San Francisco Bay, tidal marsh, permitting, legal problems

85-04. Dritsas, P.C. (1985), "Wetlands," *American Littoral Society*, Special Publication No. 12, Highlands, New Jersey.

A brief description of wetland (mainly the wetlands of the Eastern Coast of the U.S.) values and ecology is given. The roles of the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and the Environmental Protection Agency in the permitting process is outlined in broad terms.

Keywords: tidal marsh, freshwater marsh, ecology, permitting

85-05. Eliot, W. (1985), "Implementing Mitigation Policies in San Francisco Bay: A Critique," California State Coastal Conservancy, Oakland, California.

Fifty-eight development projects that required mitigation within the San Francisco Bay area are evaluated. The effectiveness of mitigation policies in achieving wetland restoration are assessed and policies are recommended to improve the success of wetland development mitigation. Mitigation banking is recommended, especially for small mitigation projects, when it is impossible to mitigate on-site, in-kind. It is also suggested that mitigation requirements be stated more clearly in the Army Corps of Engineers' permits.

Keywords: San Francisco Bay, permitting, mitigation banks

85-06. Ferren, W.R. (1985), "Carpinteria Salt Marsh, Environment, History, and Botanical Resources of a Southern California Estuary," Publication No. 4, The Herbarium, University of California, Santa Barbara.

A detailed survey of the physical environment and the history of Carpinteria Salt Marsh is given in the report. An inventory of floral species with illustrations is included along with proposed alterations to the marsh and their potential impacts.

Keywords: Southern California, plant ecology

85-07. Frey, R.W. and P.B. Basan (1985), "Coastal Salt Marshes," In R.A. Davis, Jr. (ed.), *Coastal Sedimentary Environments*, pp. 225-301, Second Edition, Springer-Verlag, New York.

The sediment characteristics of coastal salt marshes of the United States are described in detail in the chapter. Environmental conditions and marsh zonation, plant characteristics, sediment characteristics, substrate characteristics, biogeochemistry, processes affecting sedimentation, and sedimentary structures are all discussed.

Keywords: plant ecology, sedimentation, tidal marsh, soil, geomorphology

85-08. Griggs, G. and L. Savoy (1985), *Living With the California Coast*, Duke University Press, Durham, North Carolina.

The entire coastline of California is mapped and classified according to beach type and susceptibility to erosion. Coastal beaches with marshes, sand dunes, cliffs and other outstanding features are clearly marked. This book is directed toward individuals interested in property along the coast and the possible impact of site location for marshes adjacent to the coast. There is no specific information on the saltwater marshes which are included on the map, furthermore, inland marshes are not located on the map. Permitting information is provided for projects which fall under the jurisdiction of federal and state coastal zone management.

Keywords: Southern California, Northern California, Central California, erosion control, permitting

85-09. Herschy, R.W. (1985), *Streamflow Measurement*, Elsevier Applied Science Publishers, Ltd., Essex, England.

All methods of streamflow measurement are described in the book along with special problems that may be encountered, and the accuracy of the measurement methods. Of interest is the discussion on field measurement using current meters.

Keywords: monitoring

85-10. Krone, R.B. (1985), "Simulation of Marsh Growth Under Rising Sea Levels," In *Proceedings of the ASCE Special Conference on Hydraulics and Hydrology in the Small Computer Age*, Orlando, Florida, pp. 106-115.

A method for calculating the rise of a marsh surface is presented. The effects of tidal and sea level variations, aggregation and deposition of cohesive suspended sediments, and the density and organic matter content of the marsh soil are all considered in the computation method. An effective suspended sediment concentration in the flooding water is obtained by calibration. Measurements of historical surface elevations can be used to include the effects of subsidence and consolidation.

Keywords: sea level rise, soil, hydrodynamics, sedimentation

85-11. Lee, C.R., J.G. Skogerboe, K. Eskew, R.A. Price, N.R. Page, M. Clar, R. Kort, and H. Hopkins (1985), "Restoration of Problem Soil Materials at Corps of Engineers Construction Sites," Instruction Report EL-85-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

The report includes the following chapters: identification of problem soil environments, planning the restoration of problem soil material sites, land treatment and soil/regolith conditioning measures, vegetative stabilization of problem soil materials, and non-vegetative stabilization practices. Several appendixes are also included in the report. The focus of the report is on upland construction sites, but some of the information is useful for coastal environments.

Keywords: soil

85-12. National Oceanic and Atmospheric Administration (1985), "National Estuarine Inventory: Data Atlas, Vol. 1: Physical and Hydrologic Characteristics," U.S. Department of Commerce, Washington, D.C.

The ninety-two estuaries included in the atlas and inventory represent 90 percent of the estuaries in the conterminous United States. Physical and hydrologic characteristics are presented in tabular form. The tables are accompanied by maps showing mixing zones, salinity boundaries, and the watershed area.

Keywords: salinity, hydrodynamics

85-13. Race, M.S. (1985), "Critique of Present Wetlands Mitigation Policies in the United States Based on an Analysis of Past Restoration Projects in San Francisco Bay," *Environmental Management*, vol. 9, no. 1, pp. 71-82.

Present wetlands mitigation policies are critiqued based on an analysis of several past restoration projects in San Francisco Bay. The San Francisco Bay projects that were reviewed were found to be unsuccessful. It is suggested that permit issuers be very careful when dealing with wetlands mitigation projects.

Keywords: San Francisco Bay, tidal marsh, marsh restoration, planning, maintenance

85-14. Ray B. Krone & Associates and M.H. Cheney (1985), "Charleston Slough Reclamation: Study of the Hydraulics and Sedimentation Processes," Prepared for the City of Mountain View, California.

Two possible reclamation options for Charleston Slough are evaluated. The first option involves creating an artificial channel to increase circulation. The second option involves breaching a dike. For each option, several different variations exist. The hydraulic computations, sedimentation estimates, project implementation (including cost estimates), and water quality are discussed in the report.

Keywords: San Francisco Bay, sedimentation, hydrodynamics, marsh restoration, construction

85-15. Ricketts, E.F., J. Calvin, J.W. Hedgpeth, and revised by D.W. Phillips (1985), *Between Pacific Tides*, 5th Edition, Stanford University Press, Stanford, California.

The primary factors affecting distribution of intertidal organisms are wave shock, type of bottom substrate and tidal exposure. Intertidal animals are described with respect to their ability to withstand or adapt to the three limiting conditions. With respect to the estuarine environment, animals living on rocky shores, sandflats, eelgrass flats and mudflats are described in terms of their appearance, habits and preferred habitats.

Keywords: invertebrates

85-16. Russell, J.E. (1985), *Construction Equipment*, Reston Publishing Company, Inc., Reston, Virginia.

Photographs and illustrations provide a quick reference to various types of construction equipment and their suitable uses. Details such as which type of bulldozer blade is appropriate for specific applications is succinctly covered. Draglines are identified as suitable for wetlands and river dredging operations. Traction coefficients for rubber tires in various materials are tabulated. Detailed production estimations for draglines, clamshells and other equipment are demonstrated.

Keywords: construction equipment, construction

85-17. Spicher, D. and M.N. Josselyn (1985), "*Spartina* (Gramineae) in Northern California: Distribution and Taxonomic Notes," *Madroño*, vol. 32, pp. 158-167.

The distribution of *Spartina* is summarized as follows: (1) *S. foliosa* reaches its most northern limit in Bodega Bay; (2) no *Spartina* of any kind is found between Bodega Bay and the Eel River delta; (3) *S. densiflora* is found in Humboldt Bay, possibly introduced via lumber ships during the 19th century; (4) *Spartina* is absent north of Humboldt Bay. Within San Francisco Bay, the distribution of *Spartina* is summarized as follows: (5) *S. patens* occurs in Southhampton Bay (between San Pablo and Suisun Bays) and does not appear to be spreading; (6) *S. alterniflora* appears at the mouth of the Alameda flood control channel and along the bay shore for a few miles south; (7) *S. anglica* was introduced from Puget Sound to Creekside Park and Corte Madera Creek in Marin County in 1977; (8) *S. densiflora* was also introduced in 1977 and is currently found in Creekside Park, Corte Madera Creek, Muzzi Marsh, and Greenwood Cove, all in Marin County.

Keywords: San Francisco Bay, Northern California, tidal marsh, plant ecology

85-18. Stevenson, J.C., J.G. Ward, and M.S. Kearney (1985), "Vertical Accretion in Marshes With Varying Rates of Sea Level Rise," In D. Wolf (ed.), *Estuarine Variability*, Prepared for the Proceedings of the Estuarine Research Federation Meeting Held at Durham, New Hampshire, July 29-August 2, 1985.

A literature search was conducted to determine if a marsh surface accretes material and rises with the rising sea level. Seventy-five percent of the marshes studied were found to be accreting material slightly faster than apparent sea level rise. It was also noted that marshes accrete more material and are general healthier if they have a large tidal range and/or are adjacent to a riverine sediment source. Catastrophic effects on salt marshes are predicted if sea level rise acceleration occurs.

Keywords: tidal marsh, sedimentation, sea level rise

85-19. U.S. Fish and Wildlife Service (1985), "Recovery Plan for the Light-Footed Clapper Rail," U.S. Fish and Wildlife Service, Portland, Oregon.

The light-footed clapper rail has suffered a decline in population due to salt marsh destruction and disturbance. A recovery plan was prepared to increase the population to 800 pairs by preserving, restoring, and/or creating approximately 10,000 acres (4,000 hectares) of wetland habitat. Recovery methods include improving tidal circulation, enhancement and creation of

low marsh (cordgrass) habitat, creating high marsh habitat and nesting hummocks, and minimizing human disturbance.

Keywords: Southern California, endangered species, birds, planning, construction

85-20. Winfield, T.P. (1985), "Chula Vista Wildlife Reserve Transplant Program," Prepared for the Port of San Diego, San Diego, California.

The marsh creation project was completed as a mitigation effort for the loss of wildlife habitat caused by dredging of the Chula Vista Small Boat Basin. Two islands were built in the San Diego Bay out of the dredge spoil. The islands were protected by dikes and left to dewater for two years prior to planting. The first planting of *Spartina* was completed in April of 1984. The first phase was experimental to determine correct elevations and locations for the final planting. The plants were obtained from a nearby marsh. The majority of the plants were transplanted to a nursery area which was chosen because it was the least saline plot (less than 60 ppt) found in the two islands. The remaining plants were placed on representative transects. Initial transplant shock and reactions to the highly saline environment were noted through the two year monitoring program. Many of the plants that died back retained viable root systems and resprouted after conditions improved or adaptations were made. Survival rates after two growing seasons were 67 to 100 percent in the transects. Plans were then made for a final planting scheme that would include more transplants of *Spartina* and the introduction of other salt marsh species.

Keywords: Southern California, dredge spoil, salinity, marsh restoration, monitoring, plant establishment

86-01. Ajmal Khan, M., and Weber, D.J. (1986), "Factors Influencing Seed Germination in *Salicornia pacifica* var. Utahensis," *American Journal of Botany*, vol. 73, pp. 1163-1167.

Salicornia pacifica var. Utahensis (Tiderstorm) Munz (Chenopodiaceace) produces small and large seeds. Both seeds require low salinity to germinate well. Large seeds will germinate when buried, but small seeds require exposure to light.

Keywords: plant ecology, plant establishment

86-02. Alexander, C.E., M.A. Broutman, and D.W. Field (1986), "An Inventory of Coastal Wetlands of the USA," National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C.

Coastal wetland acreages are reported for regions and states along the United States coast. The coastal wetland types include salt marsh, fresh marsh, tidal flats, and swamp. Wetland acreages are also reported for counties within the various states in an appendix.

Keywords: tidal marsh, freshwater marsh, inventory

86-03. Boule, M. and T. Miller (1986), "Ballona Wetland Enhancement, Restoration and Management Plan, Appendix I: Biology," Prepared for the National Audubon Society, Western Regional Office, Sacramento, California.

Practical information for the restoration of the Ballona Wetland is reviewed. Data on desired plant species, current pollutant levels, and other information are presented.

Keywords: Southern California, tidal marsh, freshwater marsh, marsh restoration, planning, ecology

86-04. Broome, S.W., E.D. Seneca, and W.W. Woodhouse, Jr. (1986), "Long-term Growth and Development of Transplants of the Salt-Marsh Grass *Spartina alterniflora*," *Estuaries*, vol. 9, pp. 63-74.

Spartina alterniflora growth was monitored over ten years in a newly created and a nearby natural salt-marsh in North Carolina. 0.9 m by 0.9 m spacing was found adequate in protected areas. 0.45 m by 0.45 m or 0.6 m by 0.6 m spacing is advised when quick erosion control is needed. No difference in cover between spacing regimes was found after 4 years. Growth peaked in second growing season, declining thereafter, possibly due to intraspecific competition and nutrient depletion. Production and stability of transplanted marsh compared favorably with nearby natural marsh.

Keywords: tidal marsh, marsh restoration, plant establishment

86-05. Collins, J.N., L.M. Collins, L.B. Leopold, and V.H. Resh (1986), "The Influence of Mosquito Control Ditches on the Geomorphology of Tidal Marshes in the San Francisco Bay Area: Evolution of Salt Marsh Mosquito Habitats," In *Proceedings and Papers of the Fifty-fourth Annual Conference of the California Mosquito and Vector Control Association, Inc.*, California Mosquito and Vector Control Association, Inc, Sacramento, California.

The evolution and regression of drainage channels on the marsh surface and the impacts of mosquito control ditches on these channels are described in the geomorphic studies of Petaluma Marsh. The focus of the article is on the creation of prime mosquito breeding ground in retrogressing natural channels. Drainage channels fill in from the top down by trapping debris and silt in overhanging vegetation. The subterranean channels thus formed are ideal for mosquitos. It is stated that mosquito ditches should be placed to reopen these channels. Placing ditches in other areas may speed the retrogression of natural channels and increase mosquito breeding in the marsh.

Keywords: San Francisco Bay, hydrodynamics, geomorphology, mosquito control

86-06. Environmental Laboratory (1986), "Field Guide for Low-Maintenance Vegetation Establishment and Management," Instructional Report R-86-2, U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

Information on selecting plant materials and planting methods for upland plant establishment is provided in the manual.

Keywords: plant establishment

86-07. Faber, P.M. (1986), "Interim Report on the Current Status of Muzzi Marsh: Report #5," Prepared for the Golden Gate Bridge, Highway and Transportation District.

The condition of the Muzzi Marsh (a Marin County marsh restored in 1976) is evaluated. Sedimentation within the channels is studied along with vegetative cover, soil conditions, and animal use.

Keywords: San Francisco Bay, hydrodynamics, sedimentation, marsh restoration, monitoring, plant establishment

86-08. Fontana, M.G. (1986), *Corrosion Engineering*, McGraw-Hill, Inc., New York.

Seawater can cause galvanic and crevice corrosion in metals. Corrosion is affected by dissolved oxygen levels, water velocity, temperature, and biological organisms. The greatest threat of corrosion on metals occurs in the splash zone above high tide. Various metals are ranked according to their suitability for use in marine environments. Titanium, and Hastelloy (trademark Union Carbide Corp.) are the most resistant materials to corrosion in seawater.

Keywords: corrosion, construction, maintenance

86-09. Garbisch, E.W. (1986), "Highways and Wetlands: Compensating Wetland Losses," Report No. FHWA-IP-86-22, Federal Highway Administration, Washington, D.C.

Basic mitigation techniques for wetland losses due to highway construction are provided in this manual for state highway agencies. The manual is comprehensive, yet necessarily general to cover all regions of the United States and all types of wetlands form freshwater marsh to tidal salt marsh. A step-by-step approach to wetland mitigation is provided in the manual.

Keywords: ecology, marsh restoration, planning, construction

86-10. Harvey, H.T. and M.N. Josselyn (1986), "Wetland Restoration and Mitigation Policies: Comment," *Environmental Management*, vol. 10, no.5, pp. 567-569.

The authors respond to an article by Dr. Margaret Race, which questions the feasibility of wetland restoration. Several claims made in Race's article are disputed in the paper.

Keywords: San Francisco Bay, marsh restoration

86-11. Kadlec, J.A. (1986), "Effects of Flooding on Dissolved and Suspended Nutrients in Small Diked Marshes," *Canadian Journal of Fish and Aquatic Sciences*, vol. 43, pp. 1999-2008.

The effects of flooding on nutrient levels in diked marshes is discussed in the paper. No significant effects of flooding on nutrient levels were reported.

Keywords: chemistry and nutrients, monitoring

86-12. Kadlec, J.A. (1986), "Input-Output Nutrient Budgets for Small Diked Marshes," *Canadian Journal of Fish and Aquatic Sciences*, vol. 43, pp. 2009-2016.

Water budgets and nutrient budgets were carried out for eight diked marshes , approximately 4 to 6 ha in size, in Manitoba, Canada.

Keywords: chemistry and nutrients, monitoring

86-13. Meiorin, E.C. (1986), "Urban Stormwater Treatment at Coyote Hills Marsh: Final Report," Association of Bay Area Governments, Oakland, California.

An experimental marsh, designed to treat urban stormwater runoff, was constructed at Coyote Hills Marsh in South San Francisco Bay. The marsh's features are described and the marsh's treatment efficiency is evaluated. Techniques used to monitor the marsh are also described in detail.

Keywords: San Francisco Bay, hydrodynamics, marsh restoration, plant establishment, monitoring, wastewater treatment

86-14. Mitsch, W.J. and J.G. Gosselink (1986), *Wetlands*, Van Nostrand Reinhold Co., New York.

The wetland environment is described in terms of its hydrology, chemistry, geomorphology, and ecosystem development. The different types of wetlands are defined, including all categories of coastal and inland wetlands. A discussion is presented on the classification, inventory and management of wetland areas.

Keywords: classification, ecology, water quality, hydrodynamics, inventory

86-15. National Audubon Society (1986), "Ballona Wetland Habitat Management Plan: Draft," National Audubon Society, Western Regional Office, Sacramento, California.

The plan to establish a 216 acre Audubon Wildlife Sanctuary within a one hour drive of 10 million people is presented for the City of Los Angeles. An important aspect of the restoration is public access and interpretive display centers. The project is to be constructed in phases to minimize damage to existing habitat values.

Keywords: Southern California, tidal marsh, freshwater marsh, marsh restoration, planning, structures

86-16. Rapp & French (1986), "Ballona Wetland Landscape and Access Plan, Appendix III: Landscape," Prepared for the National Audubon Society, Western Regional Office, Sacramento, California.

Drawings and sketches of the proposed Ballona Wetland restoration site are provided in the document. Landscaping and access are highlighted in the plan.

Keywords: Southern California, planning

86-17. Rivertech, Inc. (1986), "Ballona Wetland Integrated Engineering Plan, Appendix II: Engineering," Prepared for the National Audubon Society, Western Regional Office, Sacramento, California.

The stormwater plan, freshwater plan, saltwater plan, and long-term operation and maintenance plan for the Ballona Wetland restoration project are described in detail in the report. Results of the hydrodynamic model developed specifically for the Ballona Wetland project are also included in the report.

Keywords: Southern California, hydrodynamics, marsh restoration, planning, structures, maintenance

86-18. Wang, J.C.S. (1986), "Fishes of the Sacramento-San Joaquin Estuary and Adjacent Waters, California: A Guide to the Early Life Histories," Technical Report No. 9, Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, Department of Water Resources, Sacramento, California.

Drawings and descriptions of juvenile fishes in the San Francisco Bay estuary provide a method of identifying very young fish, which are the most common fish found in salt marshes. The manual also provides notes on the origin, reproduction, and general life history of the animals.

Keywords: San Francisco Bay, fish, monitoring

86-19. Zedler, J.B. and C.S. Nordby (1986), "The Ecology of Tijuana Estuary, California: An Estuarine Profile," Biological Report 85(7.5), U.S. Fish and Wildlife Service, Washington, D.C.

The Tijuana Estuary is very unique compared to other estuaries in the United States. The salinity changes seasonally and it does not contain a major embayment. Relatively large populations of endangered species reside or utilize the area. Upland transition habitat is being threatened by urban encroachment, competition by exotic plant species and feral animals. The flood of 1980 and the closure of the estuary mouth in 1984 resulted in serious changes in species composition and distribution. The Tijuana Estuary is a designated National Estuarine Sanctuary.

Keywords: Southern California, tidal marsh, ecology, salinity

86-20. Zedler, J.B., P.B. Williams, and J. Boland (1986), "Catastrophic Events Reveal the Dynamic Nature of Salt-Marsh Vegetation in Southern California," *Estuaries*, vol. 9, pp. 75-80.

Observed seasonal growth of cordgrass in the Tijuana Estuary is related to observed variations in hydrological regime and associated soil salinity. Cordgrass subjected to low salinity early in the growing season showed increased growth, primarily through stem elongation. Cordgrass subjected to lowered soil salinities later and throughout the growing season resulted in increased density of growth. Increased salinity resulted in poor growth.

Keywords: Southern California, tidal marsh, water quality, salinity, hydrodynamics, plant establishment, plant ecology

87-01. Adamus, P.R., ARA Inc., E.J. Clairan, R.D. Smith, and R.E. Young (1987), "Wetland Evaluation Technique, Vol. II: Methodology," U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

The Wetlands Evaluation Technique (WET), Version 2.0, was developed to assess functions and values of wetlands under consideration for development and mitigation projects. Answers to questions about a wetlands' physical, biological and chemical characteristics are interpreted by the program. A probability rating of high, moderate or low is assigned to fourteen different wetland functions. The functions are evaluated in terms of social significance, effectiveness and opportunity. Answers to the questions can also be utilized to determine habitat suitability for fish, waterfowl and wetland birds.

Keywords: classification, planning, permitting

87-02. Allen, G.H. and D. Hull (1987), "Restoring of Butcher's Slough Estuary: A Case History," In O.T. Magoon et al. (eds.), *Proceedings of the Fifth Symposium on Coastal and Ocean Management (Coastal Zone '87)*, pp. 3674-3687, American Society of Civil Engineers, New York.

The physical history of the site, planning issues and processes used to reach a final restoration plan, construction methods and costs, some expected management problems, and research opportunities offered by the completed project are documented for the Butcher's Slough restoration project.

Keywords: Northern California, marsh restoration, construction, permitting

87-03. Baldwin, M.F. (1987), "Wetlands: Fortifying Federal and Regional Cooperation," *Environment*, vol. 29, no. 7, pp. 16-20, 39-43.

Wetlands are being destroyed by development at a high rate. To develop an effective wetlands regulation program, local, state and federal agencies will need to work together more closely and efficiently. It is suggested that regions use areawide planning, which utilizes federal, state and local governments plus public participation, to determine which wetlands must be conserved and which wetlands may be acceptable for development.

Keywords: planning, permitting

87-04. Coats, R., C. Farrington, and P.B. Williams (1987), "Enhancing Diked Wetlands in Coastal California," In O.T. Magoon et al. (eds.), *Proceedings of the Fifth Symposium on Coastal and Ocean Management (Coastal Zone '87)*, pp. 3688-3700, American Society of Civil Engineers, New York.

Diked wetlands may have considerable wildlife habitat value and dike breaching may not be the best method of enhancing that value. A flow model is available (MPOND) that can be used to predict the effects of water control structures on water surface elevations, flow rates and sedimentation rates in ponded water. Caution, field testing and expert advice should accompany the use of the model for design purposes.

Keywords: hydrodynamics, sedimentation, marsh restoration, planning

87-05. Collins, L. M., J. N. Collins, and L. B. Leopold (1987), "Geomorphic Processes of an Estuarine Marsh: Preliminary Results and Hypothesis," In V. Gardiner (ed.), *International Geomorphology 1986, Part I*, pp. 1049-1072, John Wiley & Sons Ltd., Chichester, Great Britain.

Extensive topographical and plant cover studies were undertaken within a pristine salt marsh on the banks of the Petaluma River, 10 miles north of San Francisco. Important hypotheses presented include: (1) primary production of vascular plants in first order channels causes channel retrogression; (2) within a closed drainage system, tidal prism continuity requires erosion to compensate for retrogression; (3) most geomorphic change results from biogenic activity that regulates the distribution of tidal energy across marsh plains; and (4) marsh plains are cybernetic ecosystems, wherein primary productivity decreases if the surface of the accumulated peat exceeds the elevation coincident with optimal duration or frequency of tidal inundation.

Keywords: San Francisco Bay, chemistry and nutrients, tidal marsh, plant ecology, soil, sedimentation, erosion control

87-06. Cuneo, K.L.C. (1987), "San Francisco Bay Salt Marsh Vegetation Geography and Ecology: A Baseline for Use in Impact Assessment and Restoration Planning," PhD. Dissertation, University of California, Berkeley, California.

The elevations of different salt marsh habitat units in San Francisco Bay are analyzed and a method to determine the probable elevations of habitat units in marsh restoration projects is presented. Specific areal distributions of different habitat units for different regions of the bay are recommended, along with long and short range goals for restoration efforts. Guidelines for planting to encourage use by salt marsh harvest mice and the California clapper rail are also recommended.

Keywords: San Francisco Bay, classification, plant establishment, marsh restoration, planning

87-07. Dunn, P.V. (1987), "Endangered Species Management in Southern California Coastal Salt Marshes: A Conflict or an Opportunity," In *Proceedings of the Conference on the Conservation and Management of Rare and Endangered Plants*, pp. 441-446, California Native Plant Society, Sacramento, California.

Single species management for the California clapper rail and California least tern have caused problems for efforts in protecting the endangered plant, salt marsh bird's beak. This problem will likely become more severe unless the three species are managed together in a whole system management approach.

Keywords: Southern California, endangered species, planning, plant ecology

87-08. Dyer, P. (ed.) (1987), "Northwest Wetlands: What Are They? For Whom? For What?," Conference Proceedings, Institute for Environmental Studies, University of Washington, Seattle, Washington.

An introduction into the activities and responsibilities of different agencies involved with wetland mitigation in Washington and Oregon is given in the proceedings.

Keywords: Northern California, economic value, legal problems, ecology, permitting

87-09. Faber, P.M. (1987), "A Marsh Revived," *California WaterfrontAge*, vol. 3, no. 1, pp. 28-29.

A brief history and summary of the Muzzi Marsh restoration project is given. The formerly diked wetland in Marin County was restored to tidal activity as mitigation for the Larkspur Ferry Terminal in 1976. By 1979 pickleweed was well established in much of the marsh. In 1981 the site was modified by dredging channels to the landward portions of the marsh, but siltation is decreasing the channel volume. There are currently 125 acres of healthy saltmarsh habitat. Elevations and hydrology are key factors in the viability and longevity of a marsh ecosystem. Plants are indicators of these factors.

Keywords: San Francisco Bay, tidal marsh, hydrodynamics, marsh restoration

87-10. Ferren, W.P., D.G. Caprale, and D. Hickson (1987), "University of California, Santa Barbara Campus Wetlands Management Plan: Part I - Technological Report on the Botanical Resources of West and Storke Campuses," Environmental Report No. 12, The Herbarium, University of California, Santa Barbara.

The history, physical environment and vegetation of the wetlands of the West and Storke Campuses of the University of California, Santa Barbara are described. The vegetation and wetlands are classified according to the U.S. Fish and Wildlife Service procedures. Various enhancement and restoration proposals are presented and discussed.

Keywords: Southern California, tidal marsh, freshwater marsh, plant ecology, marsh restoration

87-11. Griffis, R.B. (1987), "A Floral and Invertebrate Faunal Survey of Unrestored, Restored, and Natural Saltmarsh Habitats of the Seal Beach National Wildlife Refuge, Seal Beach Naval Weapons Station: The Effects of Wetland Restoration Measures," U.S. Naval Weapons Station, Seal Beach, California.

Portions of the Seal Beach National Wildlife Refuge were restored to tidal action in 1982 by the removal of portions of roads that ran through the marsh. A survey of the effect of the restoration measures on benthic invertebrates was completed in 1984. At that time there were significantly fewer species present in the restored areas versus the undisturbed (control) areas. In 1986, another study was performed to determine further effects of restoration on benthic invertebrates and salt marsh flora. After four years, there was no statistical difference between abundance of invertebrate species found in the restored and control marshes. Diversity, abundance, and total number of plant species were lower in the restored marsh. Pickleweed dominated the restored areas, making up 90 percent of the total abundance.

Keywords: Southern California, invertebrates, tidal marsh, monitoring, marsh restoration

87-12. Haltiner, J. and P.B. Williams (1987), "Hydraulic Design in Salt Marsh Restoration," National Symposium on Wetland Hydrology, Chicago, Illinois.

The hydraulic design considerations for salt marsh restoration and creation are discussed in detail. Methods for designing tidal sloughs and channels are described, as is the modification of marsh topography and the use of hydraulic structures to control tide heights.

Keywords: hydrodynamics, marsh restoration

87-13. Josselyn, M.N., J.M. Duffield, and M.L. Quammen (1987), "An Evaluation of Habitat Use in Natural and Restored Tidal Marshes in San Francisco Bay, CA," In O.T. Magoon et al. (eds.), *Proceedings of the Fifth Symposium on Coastal and Ocean Management (Coastal Zone '87)*, pp. 3085-3094, American Society of Civil Engineers, New York.

Waterbird and fish habitat utilization was compared within a restored wetland (Hayward Regional Shoreline) and a natural marsh (San Leandro Bay) in San Francisco Bay. The natural marsh received more waterbird use than the restored marsh. Shorebirds utilized the high marsh plain areas in the natural marsh, but did not utilize the artificial islands constructed as part of the Hayward Marsh restoration. Public access was found to greatly diminish wildlife use in the restored marsh. There was no significant difference in fish utilization between the two marshes. Fish were found to prefer sheltered mud habitats over open water habitats exposed to significant wave action.

Keywords: San Francisco Bay, birds, fish, tidal marsh, marsh restoration

87-14. Livingston, R.J. (1987), "Field Sampling in Estuaries: The Relationship of Scale and Variability," *Estuaries*, vol. 10, no. 3, pp. 194-207.

Valuable data that could be used for accurate prediction of long-term ecological trends may be lost due to infrequent sampling or missing the important sampling times. Monthly and quarterly sampling intervals were compared to weekly results for eight years to determine which regime best correlated to overall yearly trends. Most physical-chemical parameters can be sampled monthly and still be used to extrapolate yearly trends. Quarterly intervals were not successfully projected for highly variable parameters such as salinity. Quarterly sampling of infaunal invertebrates can be correlated to long-term monthly trends. Fish sampling on a quarterly basis was unrepresentative of long-term monthly patterns. An additional consideration in choosing sampling regimes is the occurrence of peaks in population and species diversity. The peaks should be known and incorporated into the sampling schedule. Choosing a sampling location should involve knowledge of the changes in productivity of the area. Species numbers and diversity will change along productivity gradients.

Keywords: monitoring

87-15. McCreary, S. (1987), "Toward Affirmative Restoration," *California WaterfrontAge*, vol. 3, no. 1, pp. 11-18.

The concept of mitigation was introduced through passage of the National Environmental Planning Act in 1969. Mitigation has evolved to represent several different courses of action, including habitat restoration on or off the development site. There have been many failures associated with the restoration of degraded wetlands, but they can usually be explained by lack of scientific knowledge and poor planning or supervision. The potential to expand wetland acreage and to increase wetland productivity is available. Strict regulations,

monitoring, cooperation between organizations and the scientific community, and the incorporation of regional goals into the planning process are required to ensure restoration success.

Keywords: marsh restoration, planning, regulations

87-16. Meyer, P.A. (1987), "The Value of King Salmon, Harbor Seals and Wetlands of San Francisco Bay," The Bay Institute of San Francisco, Sausalito, California.

Based on a survey of Bay Area and Sacramento residents and using economic theory, the monetary value of King Salmon, Harbor Seals and wetlands of San Francisco Bay is determined.

Keywords: San Francisco Bay, economic value

87-17. Mitchell, P. (ed.) (1987), "Dutra/Morrison-Knudsen Continue Work in $12.5 Million Montezuma Slough Project," *World Dredging and Marine Construction*, vol. 23, no. 10, pp. 6-11.

To combat increasing salinity levels in the Suisun Marsh, due to reduced freshwater inflows, the California Department of Water Resources decided to build a control structure at the entrance of the marsh in the Montezuma Slough. The construction and installation of the control structure is described.

Keywords: San Francisco Bay, construction equipment, marsh restoration, dredging, structures

87-18. Moffatt & Nichol, Engineers (1987), "Anaheim Bay Mitigation Project, Final Report," Prepared for the Port of Long Beach, Long Beach, California.

Four sites within Anaheim Bay were restored as mitigation for a pier expansion in San Pedro Bay. A link-node model was used to predict water surface elevations and channel velocities. Channel velocities were designed to be less than 3 ft/sec to prevent the occurrence of scouring damage. Islands, low marsh, open water, and mudflats were created within the sites to increase fish and endangered species habitat. Manual plantings were not undertaken because it was assumed that natural revegetation would take place.

Keywords: Southern California, marsh restoration, construction, monitoring

87-19. Moffatt and Nichol, Engineers, Wetlands Research Associates, Inc., and San Francisco Bay Conservation and Development Commission Staff (1987), "Sea Level Rise: Predictions and Implications for San Francisco Bay," Prepared for San Francisco Bay Conservation and Development Commission, San Francisco, California.

Changes in sea level in San Francisco Bay, impacts of sea level rise on San Francisco Bay wetlands, and design standards for protection of shoreline structures from high water levels and wave action are discussed in the report.

Keywords: San Francisco Bay, sea level rise, sedimentation, planning, structures

87-20. Nelson, B. (1987), "Mitigation in San Francisco Bay: But Where and How?," *California WaterfrontAge*, vol. 3, no. 1, pp. 23-27.

The shortcomings of mitigation in San Francisco Bay are discussed. Some mitigation techniques include giving money to state agencies to be used for wetlands acquisition and preservation, buying and protecting wetlands directly (with no enhancement), performing mitigation "out of kind" and mitigation banking. All of these techniques are not wholly adequate.

Keywords: San Francisco Bay, mitigation banks, planning

87-21. Newton, G.A. (1987), "The Ecology and Management of Three Rare Salt Marsh Species in Humboldt Bay," In *Proceedings of the Conference on the Conservation and Management of Rare and Endangered Plants*, pp. 263-266, California Native Plant Society, Sacramento, California.

Humboldt Bay owl's clover grows in the middle to high marsh either in lone stands, in pickleweed-jaumea associations, or in pickleweed-saltgrass associations. It may be parasitic to the other plants it associates with. Point Reyes bird's beak and Humboldt Bay gumplant are also discussed. Manual introduction of pickleweed is recommended to discourage monotypic stands of the exotic *Spartina densiflora*.

Keywords: Northern California, endangered species, plant ecology, plant establishment

87-22. Onuf, C.P. (1987), "The Ecology of Mugu Lagoon, California: An Estuarine Profile," Biological Report 85(7.15), U.S. Fish and Wildlife Service, Washington, D.C.

Mugu Lagoon is an extremely valuable estuary, as large concentrations of endangered species and many other species of wildlife frequent or reside in the area. The high faunal use is mainly the result of protection afforded by the presence of the lagoon on Point Mugu Naval Air Station property. The lagoon is designated a National Recreation Area but is managed by the Navy and access is controlled. The ecosystem is changing drastically due to sedimentation. Storms in 1978 and 1980 caused heavy erosion of the watershed and were responsible for decreasing depths in the lagoon by as much as 42 percent. The central basin is now primarily tidal flats, where it was predominantly open water prior to 1978. Long-term protection plans are being considered that may include diversion of flood waters and channelization. The western arm was reopened to tidal flow in 1979 and populations of some endangered species appear to be increasing.

Keywords: Southern California, sedimentation, tidal marsh, ecology, marsh restoration

87-23. Peters, D.D. and J.A. Bohn (1987), "National Wetlands Inventory Mapping for San Francisco Bay/Delta Area, California," In O.T. Magoon et al. (eds.), *Proceedings of the Fifth Symposium on Coastal and Ocean Management (Coastal Zone '87)*, pp. 1171-1182, American Society of Civil Engineers, New York.

The paper includes information on wetlands mapping for the San Francisco Bay/Delta area. Mapping techniques are discussed and older maps made in the 1950's and 1970's are compared to the newly constructed 1985 maps.

Keywords: San Francisco Bay, monitoring, inventory

87-24. Phillips, P.L. (1987), "Wetlands Mitigation: Harmon Meadows Case Sends Mixed Signals," *Urban Land*, vol. 46, no. 9, pp. 36-37.

In New Jersey, a severely degraded coastal wetland area was restored as mitigation for the filling (for development) of an existing coastal wetland. The Corps of Engineers issued a permit to fill the existing wetland, which was unsuccessfully challenged by environmental groups. The project went on as planned and the other wetland site was restored. The restoration seems to be successful, but it is still to early to know with certainty. As a result of the project, questions have arisen concerning the Corps' permit processing and future projects may become stalled by litigation.

Keywords: tidal marsh, marsh restoration, permitting

87-25. Riddle, E.P. (1987), "Mitigation Banks: Unmitigated Disaster or Sound Investment?," *California WaterfrontAge*, vol. 3, no. 1, pp. 37-40.

Mitigation banking is one method of wetlands mitigation. An agency buys a degraded wetland site and enhances it or restores it. The agency then sells mitigation credits to developers as mitigation for wetlands development. The sponsoring agency gets reimbursed for its restoration project from the developers. A mitigation bank is different from an lieu fee program, which is a process whereby developers pay into an account that is used to purchase and enhance a wetland after the development takes place. The pluses and minuses of mitigation banks are described.

Keywords: mitigation banks, planning, permitting

87-26. Simenstad, C.A. (1987), "The Role of Pacific Northwest Estuarine Wetlands in Supporting Fish and Motile Macroinvertebrates: The Unseen Users," In P. Dyer (ed.), *Northwest Wetlands: What Are They? For Whom? For What?*, pp. 29-35, Conference Proceedings, Institute for Environmental Studies, University of Washington, Seattle, Washington.

Wetlands provide various functions to different fish and macroinvertebrates. These functions include residence, reproduction, food web support, and refugia from predation.

Keywords: fish, invertebrates, tidal marsh

87-27. Stockdale, E.C. and R.R. Horner (1987), "Prospects for Wetlands Use in Stormwater Management," In O.T. Magoon et al. (eds.), *Proceedings of the Fifth Symposium on Coastal and Ocean Management (Coastal Zone '87)*, pp. 3701-3714, American Society of Civil Engineers, New York.

Wetlands water quality improvement principles are summarized, and areas of greatest uncertainty regarding the use of wetlands for urban stormwater management are discussed in the paper.

Keywords: wastewater treatment

87-28. Treais, L. (ed.) (1987), "A Citizens' Report on the Diked Historic Baylands of San Francisco Bay," The Bay Institute of San Francisco, Sausalito, California.

Two-hundred and eighty square miles of wetlands have been diked off from the bay. Of those diked wetlands, all but 80 square miles (51,156 acres) have been filled, dredged or otherwise destroyed. Currently there are numerous development proposals that will further reduce the area of diked wetlands. Case studies of 16 key sites are discussed. Tighter control of diked wetland development at all levels of government, particularly local governments, is recommended. Caution is urged when restoring the wetlands back to tidal action because the existing diked wetlands offer different habitats to which many species have become adapted.

Keywords: San Francisco Bay, tidal marsh, marsh restoration, regulations, permitting

87-29. Wang, F.C. (1987), "Effects of Levee Extension on Marsh Flooding," *American Society of Civil Engineers, Journal of Water Resources Planning and Management*, pp. 161-176.

A case study of a one dimensional model application to a Louisiana marsh is presented in the article. The effects of extending flood protection levees into the marsh is investigated. It is concluded that the flow pattern changes would result in lower water levels in the marsh and possible changes to the ecosystem.

Keywords: hydrodynamics

87-30. Williams, P.B. and M.N. Josselyn (1987), "Recommendations for Salinity Standards to Maintain the Wetlands of Suisun Marsh," Prepared for the San Francisco Bay Conservation and Development Commission, San Francisco, California.

As freshwater outflows from the Delta continue to decrease due to upstream diversions, Suisun Marsh salinities continue to increase. The increase in salinity has had adverse affects on the brackish marsh vegetation, including reduced production and takeover by more salt tolerant marsh species such as Salicornia and Spartina. In 1978, the State Water Resources Control Board adopted flow and salinity standards to protect the managed brackish wetlands of Suisun Marsh. The management goals and salinity requirements for the Suisun Marsh are reviewed based on information developed since 1978.

Keywords: San Francisco Bay, tidal marsh, salinity, hydrodynamics, plant establishment

87-31. Winfield, T.P. (1987), "Chula Vista Wildlife Reserve, Transplant Program - Final Report," Prepared for the Port of San Diego, San Diego, California.

The final phase of the development of the Chula Vista Wildlife Reserve was completed during late March to early April 1986. Plant material was obtained from nearby Sweetwater Channel. The transplants were twelve inch blocks of pure *Spartina* or mixed associations of salt marsh plants. The mixed association blocks were placed mainly at elevations of 5 to 6 ft (MLLW) and cordgrass was placed predominantly at 4 to 5 ft (MLLW). The transplants were monitored during their first growing season. The overall success was determined by a greater than 99 percent survival rate. The majority of dead plants were located above 5 ft (MLLW). The occurrence of silt-clay sediments in the higher elevations may have affected survival rates. The initial transplants continued to improve through their third growing season,

indicating adaptation to the highly saline environment. Fear of dike failure has prompted consideration of more permanent protection structures.

Keywords: Southern California, marsh restoration, monitoring, plant establishment

87-32. Wolfe, D.A., M.A. Champ, D.A. Flemer, and A.J. Mearns (1987), "Long-Term Biological Data Sets: Their Role in Research, Monitoring, and Management of Estuarine and Coastal Marine Systems," *Estuaries*, vol. 10, no. 3, pp. 181-193.

Long-term biological data are not readily available for estuarine systems. High costs and the large time commitment for extensive monitoring programs have contributed to the lack of data. Hypotheses should be generated prior to designing the monitoring regime and the data gathering should be completed with the original hypothesis in mind. The data should also be gathered to meet the needs of the marsh manager. Spatial and temporal variability within the estuary should be considered when choosing sampling locations and sampling frequencies. Methods should be clearly defined, standardized, and calibrated for reproduction and comparison with other areas.

Keywords: monitoring

87-33. Zedler, J.B. (1987), "An Ecologist's View: Mitigation Problems on the Southern California Coast," *California WaterfrontAge*, vol. 3, no. 1, pp. 32-36.

Regulations in California are not preventing wetland destruction. Mitigation has become a license to develop. The argument in support of mitigation has been that quantity is being traded for quality. The issue of quality is presently in question. The process of restoration can damage ecosystems, and the enhancement of species diversity at one site doesn't necessarily increase regional diversity. Too often the expansion of wetlands has involved the destruction of other types of habitats and has had questionable success.

Keywords: marsh restoration, planning, regulations

88-01. Athanas, C. (1988), "Wetlands Creation for Stormwater Treatment," In J. Zelany and J.S. Feierabend (eds.), *Proceedings of a Conference: Increasing Our Wetland Resources*, pp. 61-66, National Wildlife Federation, Washington, D.C.

The use of man-made freshwater wetlands to treat urban stormwater runoff is discussed in the paper. Some sizing criteria for artificial wetlands are provided and vegetation establishment methods are discussed briefly.

Keywords: wastewater treatment

88-02. California Department of Parks and Recreation (1988), "California Wetlands: An Element of the California Outdoor Recreation Planning Program," California Department of Parks and Recreation, Sacramento, California.

Wetlands benefits and functions are outlined and the factors influencing loss or degradation of wetlands are described. Explanations of wetland protection mechanisms, the effectiveness of wetlands protection, management goals for wetlands protection are provided in the report.

Keywords: tidal marsh, freshwater marsh, regulations, permitting

88-03. Carlin, M.P. (1988), "Proposed Wetlands Policy Procedural Guidelines for the San Francisco Bay Region," California Regional Water Quality Control Board, San Francisco Bay Region, San Francisco, California.

The procedural guidelines for the CRWQCB wetlands policy are described. The Board's role in the permitting process is described in detail. The steps required for Water Quality Certification are outlined.

Keywords: San Francisco Bay, permitting

88-04. Chabreck, R.H. (1988), *Coastal Marshes: Ecology and Wildlife Management*, University of Minnesota Press, Minneapolis, Minnesota.

The book presents a general discussion of the processes that occur in coastal marshes. The value of marshes, anthropogenic influences, and management of marshes are also discussed. A very short section related to California marshes is included, although generalized information obtained from Gulf Coast marshes predominates. A comprehensive bibliography is included.

Keywords: tidal marsh, freshwater marsh, ecology, planning

88-05. Chapman, P.M. (1988), "Marine Sediment Toxicity Tests," In J.J. Lichtenberg, J.A. Winter, C.I. Weber, and L. Fradkin (eds.), *Chemical and Biological Characterization of Sludges, Sediments, Dredge Spoils, and Drilling Muds*, pp. 391-402, American Society for Testing and Materials, Philadelphia, Pennsylvania.

Determination of the toxicity of pollutant laden sediment requires specialized bioassay testing. Standardization of the methods used in determining toxicity is absolutely necessary. Discussion is provided in the article on collection, processing, and storing sediment samples for testing in addition to bioassay procedures.

Keywords: chemistry and nutrients, insects, soil, monitoring

88-06. Coats, J. (ed.) (1988), "Mosquito Control Research: Annual Report 1988," University of California, Division of Agriculture and Natural Resources, Davis, California.

Current research in the mosquito abatement field is discussed in the report. Of interest is a description in the closing comments of the needs of coastal districts for more research on the control of salt marsh mosquitos. Because of the proximity of endangered species in salt marshes, most chemical methods are banned and other methods require approval from the Environmental Protection Agency.

Keywords: maintenance, monitoring

88-07. Coats, R. and L. MacDonald (1988), "Use of Hydrologic Criteria in Wetland Delineation," Proceedings of the National Wetland Symposium: Urban Wetlands, June 26-29, 1988, Oakland, California.

A number of quantitative hydrologic methods that can be used to delineate and characterize wetlands are discussed in the paper.

Keywords: classification, monitoring

88-08. Constanza, R., F.H. Sklar, M.L. White, and J.W. Day, Jr. (1988), "A Dynamic Spatial Simulation Model of Land Loss and Marsh Succession in Coastal Louisiana," In W.J. Mitsch, M. Straskraba, and S.E. Jorgensen (eds.), *Wetland Modelling*, pp. 99-114, Elsevier, New York.

The CELSS model has been developed to simulate the spatial evolution of a marsh over long periods of time, and is discussed in the chapter. Deposition, erosion, subsidence, salinity, and vegetation factors are analyzed and applied to a grid-cell map of the study area. Changes in vegetation type reveal succession patterns in the marsh.

Keywords: geomorphology, planning

88-09. Eliot, W. and R. Holderman (1988), "The Huntington Wetlands: Pickleweed or Parking Lot?," *California WaterfrontAge*, vol. 4, no. 1, pp. 19-26.

The Huntington Wetlands comprise 147 acres along the southeast side of Pacific Coast Highway in Huntington Beach, California. The property is owned in parcels by development companies, a utility, and public agencies. The area was slated for development until the California Coastal Commission rejected the plan and ruled that no filling could occur. A lengthy battle ensued involving the Coastal Conservancy as mediator. Settlements were made with Caltrans and the Orange County Flood Control Agency. Land was sold to the Conservancy and funding for enhancement was provided through mitigation of road and waterway improvements. Settlements with the private owners have proved to be more difficult and the participants are still in the negotiating process.

Keywords: legal problems, marsh restoration, planning, regulations

88-10. Gale, J.G. and P.B. Williams (1988), "Integrating Tidal Wetland Restoration with Coastal Flood Basin Design: The Example of Shorebird Marsh, Corte Madera, California," In J.A. Kusler, S. Daly and G. Brooks (eds.), *Proceedings of the National Wetland Symposium: Urban Wetlands*, Association of State Wetland Managers, Berne, New York.

The criteria used to design the Shorebird Marsh in San Francisco Bay (Marin County) are discussed in the report. It was necessary to limit the tidal prism due to flooding concerns. The marsh is to function as a wetland during the dry season and as a flood control basin during the rainy season. The biggest problem is preventing the channel that connects the marsh to the bay from silting in. The channel was dredged to an optimum cross-section that

is supposed to provide adequate scouring to remove sediment deposited during the rainy season, when tidal flows are not allowed to enter the marsh.

Keywords: San Francisco Bay, hydrodynamics, sedimentation, marsh restoration, monitoring

88-11. **Hook, D.D., W.H. McKee, Jr., H.K. Smith, J. Gregory, V.G. Burrell, Jr., M.R. DeVoe, R.E. Sojka, S. Gilbert, R. Banks, L.H. Stolzy, C. Brooks, T.D. Matthews, and T.H. Shear (eds.) (1988), *The Ecology and Management of Wetlands, Volume 1: Ecology of Wetlands*, Timber Press, Portland, Oregon.**

Numerous papers on various wetland types and topics are included in the book.

Keywords: ecology

88-12. **Hopkinson, C.S., R.L. Wetzel, and J.W. Day, Jr. (1988), "Simulation Models of Coastal Wetland and Estuarine Systems: Realization of Goals," In W.J. Mitsch, M. Straskraba, and S.E. Jorgensen (eds.), *Wetland Modelling*, pp. 67-97, Elsevier, New York.**

Six ecological models for southeastern United States estuarine and salt marsh systems are reviewed in the chapter. The large scale regional models are reported to be useful for management and research oriented goals. The objectives of each model are listed along with an overview of the considerations used to obtain the stated goals.

Keywords: planning

88-13. **Jensen, L.J. (1988), "Wetlands Mitigation: An EPA View of Opportunities and Problems," In J. Zelany and J.S. Feierabend (eds.), *Proceedings of a Conference: Increasing Our Wetland Resources*, pp. 24-27, National Wildlife Federation, Washington, D.C.**

The Environmental Protection Agency's strategy to achieve the objectives of the Clean Water Act, and the EPA's role in the Section 404 dredge and fill program are discussed in the paper.

Keywords: permitting

88-14. **Josselyn, M.N. (1988), "Bracut Wetland Mitigation Bank, Biological Monitoring: 1987, Final Report," Prepared for the California State Coastal Conservancy, Oakland, California.**

Bracut Marsh was restored and expanded as a replacement for pockets of marshes that were filled in and around the City of Eureka. Excavation was completed to remove previous fill which consisted of river gravel, loam and wood debris. The excavated fill was used to construct islands in the marsh. In response to concerns over flotation of the wood debris and soil compaction after grading, bay mud was imported and placed over the islands. Tidal action was restored by dike breaching and *Spartina* was planted. In spite of the precautions, wood debris did float to the surface and is impeding water circulation. Decomposition of the buried debris is producing methane. Constructed islands have not revegetated due to acidic

conditions following aeration of the dredged spoil. Accumulation of riprap in the exit channel is causing water ponding and the formation of hydrogen sulfide.

Keywords: Northern California, mitigation banks, tidal marsh, water quality, hydrodynamics, marsh restoration, plant establishment

88-15. Josselyn, M.N. (1988), "Effectiveness of Coastal Wetland Restoration: California," In J.A. Kusler, M.L. Quammen, and G. Brooks (eds.), *Proceedings of the National Wetland Symposium: Mitigation of Impacts and Losses*, pp. 246-251, ASWM Technical Report No. 3, Association of State Wetland Managers, Berne, New York.

A number of constraints common to wetland restoration in California are identified and discussed in the paper. The constraints discussed can be grouped into four major categories, and include land subsidence, shoreline erosion, limited water availability, and habitat for endangered species and/or specific target species. A summary of research needs for improving mitigation in the Pacific states is also included in the paper.

Keywords: tidal marsh, marsh restoration

88-16. Kadlec, R.H. (1988), "Monitoring Wetland Responses," In J. Zelany and J.S. Feierabend (eds.), *Increasing Our Wetland Resources*, pp. 114-120, National Wildlife Federation, Washington, D.C.

Wetlands monitoring can be a difficult and expensive undertaking. Wetlands are dynamic systems, subject to hydrodynamic, chemodynamic, and biodynamic processes. Spatial and temporal inhomogeneity are the principal sources of variability of parameters. Replicates must be collected to ensure accuracy. Long-term data sets must be completed to assess the nature of the area adequately.

Keywords: freshwater marsh, monitoring

88-17. Kusler, J.A. (1988), "Wetland Restoration/Creation: A Summary of Science Views and Perspectives," In J.A. Kusler, M.L. Quammen, and G. Brooks (eds.), *Proceedings of the National Wetland Symposium: Mitigation of Impacts and Losses*, pp. 440-446, ASWM Technical Report No. 3, Association of State Wetland Managers, Berne, New York.

A question-and-answer format is used to summarize scientific knowledge of wetland restoration and creation techniques.

Keywords: marsh restoration

88-18. Larson, J.S. (1988), "Wetland Creation and Restoration: An Outline of the Scientific Perspective," In J. Zelany and J.S. Feierabend (eds.), *Proceedings of a Conference: Increasing Our Wetland Resources*, pp. 73-79, National Wildlife Federation, Washington, D.C.

Three important aspects of wetland creation (hydrology, soil, and vegetation) are reviewed and discussed in the paper. It is suggested that functional performance is the appropriate

scientific standard for assessing the success of artificial or restored wetlands. Restoration presents less risk of failure than does creation with respect to hydrologic functions.

Keywords: tidal marsh, soil, hydrodynamics, marsh restoration

88-19. Ledec, G. and R. Goodland (1988), *Wildlands: Their Protection and Management in Economic Development*, The World Bank, Washington, D.C.

The management and economics of wildland preservation, as opposed to development, in third world and developed countries is explored. A macro-scale approach to wildland preservation on a country-wide scale is discussed, rather than the approach required for individual projects.

Keywords: economic value, ecology, planning

88-20. Metz, E.D. (1988), "Guidelines for Planning and Designing a Major Wetland Restoration Project: Ballona Wetland Case Study," In J. Zelany and J.S. Feierabend (eds.), *Proceedings of a Conference: Increasing Our Wetland Resources*, pp. 80-87, National Wildlife Federation, Washington, D.C.

The planning process for the Ballona Wetland restoration project is reviewed in the paper.

Keywords: Southern California, marsh restoration

88-21. Morrison, J. (1988), "The Morphometry of the San Francisco Bay Estuary," Philip Williams & Associates, San Francisco, California.

The volume and tidal prism for the various components of the San Francisco Bay estuary (South Bay, San Pablo Bay, etc.) are presented in the report.

Keywords: San Francisco Bay, hydrodynamics

88-22. Morrison, J. and P.B. Williams (1988), "Warm Springs Marsh Restoration: An Example of Creative Mitigation," In J.A. Kusler, S. Daly and G. Brooks (eds.), *Proceedings of the National Wetland Symposium: Urban Wetlands*, Association of State Wetland Managers, Berne, New York.

The Warm Springs Marsh is located in South San Francisco Bay. The restoration project was done to mitigate the loss of diked historic wetlands to a business park development in Fremont, California. A large open water pond was constructed and was designed to rapidly fill with sediments. Ultimately, a marsh plain should develop. The large pond is connected to two large sloughs via dike breaches and is also designed to increase the area's tidal prism, which improves water quality (increase flushing). Monitoring is an important process used to verify design assumptions and evaluate the health and development of the marsh, which seems to be developing successfully. The design takes advantage of natural physical processes and is maintenance free.

Keywords: San Francisco Bay, hydrodynamics, sedimentation, marsh restoration

88-23 Nichols, F.H. and M.N. Pamatmat (1988), "The Ecology of the Soft-Bottom Benthos of San Francisco Bay: A Community Profile," Biological Report 85 (7.19), U.S. Fish and Wildlife Service, Washington, D.C.

The invertebrates and other soft-bottom benthos dwelling organisms of San Francisco Bay are discussed in detail in the report.

Keywords: San Francisco Bay, invertebrates

88-24. Niering, W.A. (1988), "Endangered, Threatened, and Rare Wetland Plants and Animals of the Continental United States," In D.D. Hook et al. (eds.), *The Ecology and Management of Wetlands, Volume 1: Ecology of Wetlands*, pp. 227-238, Timber Press, Portland, Oregon.

Endangered, threatened, and rare wetland plant and animal species are identified for the coastal regions of the United States. The species discussed include plants and animals found in many wetland types, including salt marshes.

Keywords: endangered species

88-25. Odum, W.E. (1988), "Predicting Ecosystem Development Following Creation and Restoration of Wetlands," In J. Zelany and J.S. Feierabend (eds.), *Increasing Our Wetland Resources*, pp. 67-70, National Wildlife Federation, Washington, D.C.

There is a general lack of knowledge regarding natural marsh development. Information regarding plant succession would be helpful in deciding if planting is necessary or advisable in light of natural invasion or crowding by disturbance species.

Keywords: marsh restoration

88-26. Onuf, C.P. and J.B. Zedler (1988), "Patterns and Processes in Arid-Region Salt Marshes - Southern California," In D.D, Hook et al. (eds.), *The Ecology and Management of Wetlands, Volume I: Ecology of Wetlands*, pp. 570-581, Timber Press, Portland, Oregon.

An overall discussion of the Southern California salt marshes and the principal differences between West Coast and East Coast salt marshes is presented in the paper.

Keywords: Southern California, ecology

88-27 Poland, J.F. and R.L. Ireland (1988), "Land Subsidence in the Santa Clara Valley, California, as of 1982," U.S. Geological Survey Paper 497-F, U.S. Government Printing Office, Washington, D.C.

Land subsidence in the Santa Clara Valley is documented in the report. The primary cause of the subsidence is due to the overdrafting of groundwater supplies.

Keywords: San Francisco Bay

88-28. Ray, D.K. and W.O. Woodroof (1988), "Approaches for Restoring and Recreating Wetlands in California's Coastal Zone," In J.A. Kusler, M.L. Quammen, and G. Brooks (eds.), *Proceedings of the National Wetland Symposium: Mitigation of Impacts and Losses*, pp. 392-402, Association of State Wetland Managers, Berne, New York.

Several estuary and wetland mitigation projects approved by the California State Coastal Commission are described in the paper. Mitigation proposal evaluation and restoration site management are also discussed briefly.

Keywords: marsh restoration, monitoring

88-29. Reed, P.B. Jr. (1988), "National List of Plant Species that Occur in Wetlands (Region 0)," Report No. 88 (26.10), U.S. Department of the Interior, U.S. Fish and Wildlife Service, Research and Development, Washington, D.C.

A dictionary of scientific and common names of wetland plant species is included in the report. No delineation is made between saltwater and freshwater plant species. An attempt is made to consolidate the number of plant species by identifying plants that are often called by more than one name. For example, *Salicornia virginica* is also known as *Salicornia pacifica*, even though they are the same species.

Keywords: plant ecology

88-30. Resh, V.H. and D.R. Batzer (1988), "Strategies for Mosquito and Invertebrate Management in Salt Marshes Impounded as Wetland Habitats," In J. Coats (ed.), *Mosquito Control Research: Annual Report 1988*, pp. 47-49, University of California, Division of Agriculture and Natural Resources, Davis, California.

In impounded salt ponds and other areas of standing saltwater, methods to control the breeding of salt marsh mosquitos are being investigated . The effects of vegetation and flooding regime are being studied. The experiments are not completed and the analyses of the results are still pending.

Keywords: San Francisco Bay, insects, maintenance, mosquito control

88-31. Rising Sun Enterprises and Omsberg & Company (1988), "Palco Marsh Enhancement Plan," Prepared for the City of Eureka and the California Coastal Conservancy, Eureka, California.

A site survey including soils, topography, hydrology, water quality, vegetation, wildlife, and land use concerns is presented for the Palco Marsh in Humboldt Bay. The site survey is followed by an enhancement and construction plan. Special attention is given to enhancing habitat for a rare plant species found on the site, and removing an invasive exotic plant species. Flood control issues are also discussed.

Keywords: Northern California, tidal marsh, freshwater marsh, marsh restoration, planning

88-32. San Francisco Bay Conservation and Development Commission (1988), "Mitigation: An Analysis of Tideland Restoration Projects," San Francisco Bay Conservation and Development Commission, San Francisco, California.

Fourteen mitigation projects were analyzed to determine how well they met their initial goals. Six projects were judged successful, five projects were considered partially successful, and three projects were unsuccessful. Included in the report are the criteria for success, descriptions of each of the projects and the reasons for success or failure, and recommendations for future mitigation projects.

Keywords: San Francisco Bay, marsh restoration

88-33. Savik, B. (1988), "Wetlands Play a Major Role in Highway Design," *Public Works*, pp. 68-69.

In New York, three ponds were created to replace lost wetland areas that were destroyed in the construction of five miles of interstate highway. The pond edges were landscaped to replace lost vegetation and to attract waterfowl. Nesting boxes were constructed to provide nesting habitat for the waterfowl.

Keywords: freshwater marsh, marsh restoration, construction

88-34. Shonman, D. (1988), "Restoration Standards: How to Guarantee Environmental Protection," *California WaterfrontAge*, vol. 4, no. 2, pp. 24-27.

Habitat restoration can be a vital tool in the battle to ensure quality and preservation of wildlands. Restoration is also experimental and thus controversial. There are seven standards that should be applied to restoration projects to increase their likelihood of success. A restored area should not be considered a replacement for an undisturbed area, and the projects should only include species native to the local biogeographic region. Restoration projects should set specific goals, include monitoring, prescribe maintenance methods, include long-term funding, and be enforceable.

Keywords: planning, regulations

88-35. Sim, P.G., W.D. Jamieson, S.S. Berman, and V.J. Boyko (1988), "Sediment Reference Materials and the Canadian Marine Analytical Chemistry Standards Program," In J.J. Lichtenberg, J.A. Winter, C.I. Weber, and L. Fradkin (eds.), *Chemical and Biological Characterization of Sludges, Sediments, Dredge Spoils, and Drilling Muds*, pp. 27-34, American Society for Testing and Materials, Philadelphia, Pennsylvania.

Reference materials have been established for comparing testing methods against known samples for trace organic and inorganic constituents in sediments. Two marine sediment samples have already been established and a specific West Coast sediment material is now under development. Seawater and river water samples are also available for calibrating test methods.

Keywords: chemistry and nutrients, soil, monitoring

88-36. Thompson, D.A. and A.H. Williams-Dawe (1988), "Key 404 Program Issues in Wetland Mitigation," In J.A. Kusler, M.L. Quammen, and G. Brooks (eds.), *Proceedings of the National Wetland Symposium: Mitigation of Impacts and Losses*, pp. 49-52, ASWM Technical Report No. 3, Association of State Wetland Managers, Berne, New York.

Legal and policy issues concerning section 404 permits are discussed in the paper. It is suggested that the currently used step-wise approach to mitigating impacts [(1) avoid; (2) minimize; (3) compensate] be continued, and that wetland restoration/creation projects should not be used as rationale to approve development projects when practical alternatives exist.

Keywords: planning, permitting

88-37. U.S. Environmental Protection Agency (1988), "America's Wetlands, Our Vital Link Between Land and Water," Report No. OPA-87-016, Office of Wetlands Protection, U.S. Environmental Protection Agency, Washington, D.C.

A general overview of the wetland situation in America is provided in the bulletin. Wetland loss rates and the present regulations concerning development are presented.

Keywords: regulations, permitting

88-38. Walker, J.R., A. Bertolotti, R.E. Flick, and C.R. Feldmeth (1988), "Hydraulic Aspects of Wetland Design," In B.L. Edge (ed.), *Twenty-First Coastal Engineering Conference Proceedings*, pp. 2666-2680, American Society of Civil Engineers, New York.

Biological characteristics and tide characteristics of Southern California coastal marshes are summarized in the paper. Hydraulic aspects of wetland design, with an emphasis on tide control structures, are described in detail.

Keywords: Southern California, hydrodynamics, marsh restoration, structures

88-39. Webb, J.W., M.C. Landin, and H.H. Allen (1988), "Approaches and Techniques for Wetlands Development and Restoration of Dredged Material Disposal Sites," In J.A. Kusler, M.L. Quammen, and G. Brooks (eds.), *Proceedings of the National Wetland Symposium: Mitigation of Impacts and Losses*, pp. 132-134, ASWM Technical Report No. 3, Association of State Wetland Managers, Berne, New York.

Salt marsh creation techniques used at U.S. Army Corps of Engineers dredged disposal sites are summarized in the paper.

Keywords: dredge spoil, tidal marsh, marsh restoration, plant establishment

88-40. Williams, P.B. (1988), "Hydrology in Coastal Wetland Restoration Design," In J.A. Kusler, M.L. Quammen, and G. Brooks (eds.), *Proceedings of the National Wetland Symposium: Mitigation of Impacts and Losses*, pp. 329-336, ASWM Technical Report No. 3, Association of State Wetland Managers, Berne, New York.

An overview of key hydrologic and hydraulic processes influencing the formation of coastal marshes typical of the Pacific Coast is provided in the paper. The effects of human disturbance on wetlands are discussed, as are hydraulic methods used in developing restoration designs.

Keywords: geomorphology, marsh restoration

88-41. Winfield, T.P. (1988), "Spring and Fall 1988 Monitoring Surveys of the Marsh Creation Project at the Chula Vista Wildlife Reserve," Letter to Bill Glaser, Port of San Diego, San Diego, California.

The dredge spoil islands in the San Diego Bay were monitored during May and October of 1988. A scale insect (*Haliaspis*) infestation was noted during visits in 1987 and persisted into the 1988 growing season. The insect attacks *Spartina* and causes stunting of growth, lower root density and fewer flowering shoots. It was determined through biological surveys of Chula Vista Wildlife Reserve and nearby healthy marshes that no natural predators of *Haliaspis* were present at Chula Vista. Controlled release of *Coleomegilla*, a beetle, is being considered. Despite the scale infestation, volunteer areas of *Spartina*, as well as other salt marsh species, are appearing. Several species of invertebrates, shorebirds and fish have moved into the marsh. Tidal channels are expanding in both islands and sand bars are forming at the dike entrances. The changes in marsh morphology do not appear to have any detrimental impacts.

Keywords: Southern California, marsh restoration, monitoring

88-42. Zarba, C.S. (1988), "Status of the U.S. Sediment Quality Criteria Development Effort," In J.J. Lichtenberg, J.A. Winter, C.I. Weber, and L. Fradkin (eds.), *Chemical and Biological Characterization of Sludges, Sediments, Dredge Spoils, and Drilling Muds*, pp. 13-17, American Society for Testing and Materials, Philadelphia, Pennsylvania.

Section 404 of the Clean Water Act authorized the EPA to develop criteria for the quality of sediment in streams, lakes, and "other waters" of the U.S. in an effort to reduce the effects of pollution on wildlife. The EPA is authorized to regulate activities which will affect the quality of these sediments. The article describes the current status of the effort by the EPA to establish criteria for sediment quality. At present, criteria is being established for levels of non-polar organic contaminants and metal contaminants. Specific pollutant values have not been determined yet.

Keywords: soil, regulations

88-43. Zedler, J.B. (1988), "Salt Marsh Restoration Lessons from California," In J. Cairns, Jr. (ed.), *Rehabilitating Damaged Ecosystems*, vol. I, pp. 124-138, CRC Press, Boca Raton, Florida.

Mitigation, as practiced by the restoration and enhancement of alternative sites, is permitting the continued loss of wetland acreage in the hope that quality will be improved. Wetlands restoration is a hope, not a guarantee. There are many lessons to be learned from past restoration projects that will increase chances for future success. Defining restoration goals,

incorporating hydrologic planning, increasing experimentation, and assessing properly the success or failure are important considerations for any restoration project.

Keywords: Southern California, marsh restoration, hydrodynamics, planning, monitoring

88-44. Zedler, J.B. (1988), "Restoring Diversity in Salt Marshes, Can We Do It?," In E.O. Wilson (ed.), *Biodiversity*, pp. 317-325, National Academy Press.

Mitigation, as permitted in California, has resulted in the loss of wetland acreage and in the replacement of functional habitat with modified habitat. A cause and effect relationship exists between loss of acreage and a decline in populations of wetland dependent species. There has not been any research done to determine a minimum wetland size to maintain biodiversity. Further research and advances are needed in the field of ecotechnology, "the manipulation of ecosystems to achieve specific management objectives." Experiments should be incorporated into restoration projects to learn whether certain methods are more applicable or successful.

Keywords: Southern California, tidal marsh, marsh restoration

88-45. Zedler, J.B. (1988), "Why It's So Difficult to Replace Lost Wetland Functions," In J. Zelany and J.S. Feierabend (eds.), *Proceedings of a Conference: Increasing Our Wetland Resources*, pp. 121-123, National Wildlife Federation, Washington, D.C.

The difficulties in replacing lost wetland functions with man-made wetlands are discussed in the paper.

Keywords: ecology, marsh restoration

89-01. AASHTO and FHWA (1989), "Summary of the Consensus Reached at the AASHTO/FHWA National Conference of Applying the Section 404 Permit Process and Wetlands Policies to Highway Projects," American Association of State Highway and Transportation Officials and the Federal Highway Administration, Washington, D.C.

A summary of the group consensus on wetland delineation, functional values, no-net-loss policy, cost-effective mitigation, and other areas is presented in the report.

Keywords: classification, regulations, permitting

89-02. ABA Consultants (1989), "Elkhorn Slough Wetland Management Plan," Prepared for the California State Coastal Conservancy, Oakland, California, and the Monterey County Planning Department, Monterey, California.

The natural history of Elkhorn Slough, erosion and sedimentation, water quality, wetland enhancement plans, plan implementation, and long-term management problems are all discussed in the report.

Keywords: Central California, ecology, marsh restoration, construction

89-03. Argent, G. (1989), "Wetlands: Private Property or Public Resource," Western Water, Water Education Foundation, Sacramento, California.

A discussion is provided on the Army Corps of Engineering 404 permitting process, EPA veto powers, and the interaction between the two agencies. In addition, discussion of other groups involved politically or financially with California wetlands is provided.

Keywords: regulations, permitting

89-04. Buckley, G.P. (ed.) (1989), *Biological Habitat Reconstruction*, Bellhaven Press, London, England.

All types of habitat restoration are covered in the book. General information is provided on habitat restoration. However, information specific to salt marshes is not provided.

Keywords: marsh restoration, planning

89-05. California State Coastal Conservancy, and Sonoma Land Trust (1989), "Sonoma Baylands Enhancement Plan," California State Coastal Conservancy, Oakland, California, and Sonoma Land Trust.

Three options for the development of diked wetlands into marshland are presented in the report. The plan serves as a good example of the marsh restoration planning process.

Keywords: San Francisco Bay, tidal marsh, marsh restoration

89-06. Coats, R., M. Swanson, and P.B. Williams (1989), "Hydrologic Analysis for Coastal Wetland Restoration," Environmental Management, vol. 13, no. 6, pp. 715-727.

An important part of the design of a successful salt marsh restoration project is quantitative hydraulic and hydrologic analysis of the alternatives. Restoration projects at two sites in California are reviewed in the paper. The design of the restoration projects included a combination of empirical geomorphic relationships, numerical modeling, and verification with field observations.

Keywords: hydrodynamics, marsh restoration

89-07. Dedrick, K.G. (1989), "San Francisco Bay Tidal Marshland Acreages: Recent and Historic Values," In O.T. Magoon et al. (eds.), *Proceedings of the Sixth Symposium on Coastal and Ocean Management (Coastal Zone '89)*, pp. 383-398, American Society of Civil Engineers, New York.

The tidal marshland acreage in San Francisco Bay was found to be 30,003 acres. The methods used to determine the above value are described in the paper. Comparisons are made with other tidal marsh acreage studies of San Francisco Bay.

Keywords: San Francisco Bay, tidal marsh, inventory

89-08. Florida Sea Grant Salt-Tolerant Vegetation Advisory Panel (1989), "An Introduction to Planting and Maintaining Selected Common Coastal Plants in Florida," Florida Sea Grant Report No. 97, Florida Sea Grant College Program.

Plant specifications and planting guidelines are given for several common coastal plants in Florida.

Keywords: plant establishment

89-09. Hicks, S.D. (1989), "Tide and Current Glossary," National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Rockville, Maryland.

Definitions of terms used to describe tidal phenomenon are included in the publication.

Keywords: tides, hydrodynamics

89-10. Josselyn, M.N., J.B. Zedler, and T. Griswold (1989), "Wetland Mitigation Along the Pacific Coast of the United States," In J.A. Kusler and M.E. Kentula (eds.), *Wetland Creation and Restoration: The Status of the Science, Volume I: Regional Reviews*, pp. 1-35, Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon.

Several aspects of wetland mitigation along the Pacific coast are discussed in the paper, including wetland types, mitigation policies, wetland restoration, and research needs.

Keywords: tidal marsh, lagoon, marsh restoration, construction, monitoring

89-11. Josselyn, M.N., M. Martindale, and J.M. Duffield (1989), "Public Access and Wetlands: Impacts of Recreational Use," Technical Report No. 9, Romberg Tiburon Centers, Center for Environmental Studies, San Francisco State University, Tiburon, California.

The affects of recreational use and different types of public access on wetlands around San Francisco Bay were evaluated. Birds were used as disturbance indicators because they were the most abundant marsh animal species and they were easiest to observe. Birds were disturbed less at marshes with high public use, but bird population densities were highest at marshes with low public use. Guidelines for the design of public access features are included in the report.

Keywords: San Francisco Bay, birds, marsh restoration, structures

89-12. Marcus, L. (1989), "The Coastal Wetlands of San Diego County," California State Coastal Conservancy, Oakland, California.

The coastal wetlands of San Diego County are characterized in a discussion of urban runoff, upstream dams and reservoirs, coastal development, and sedimentation. Each major wetland

is highlighted by its location, size, history, wildlife values, current problems, and public access. Some information about endangered species found in the region is also included.

Keywords: Southern California, tidal marsh, lagoon, ecology, water quality, sedimentation

89-13. McLusky, D.S. (1989), *The Estuarine Ecosystem*, 2nd Edition, Chapman and Hall, New York.

A general synopsis of information on the estuarine environment, estuarine pollution, and estuarine management is provided in the book. Food-web dynamics, circulation, sediments, modes of contamination, and policies and planning to prevent pollution are discussed.

Keywords: tidal marsh, salinity, soil, hydrodynamics

89-14. Nouri, H. (1989), "Building a Better Wetland," *Civil Engineering*, vol. 59, no. 8, pp. 45-46.

Computer operated tide gates will be used to regulate water levels at the Ballona Wetlands. Tidal action will be reintroduced to help restore the degraded wetlands and an environmental education center will be constructed.

Keywords: Southern California, tidal marsh, freshwater marsh, marsh restoration, planning

89-15. Riley, A.L. (1989), "Overcoming Federal Water Policies: The Wildcat-San Pablo Creeks Case," *Environment*, vol. 31, no. 10, pp. 12-31.

A discussion of the circuitous path that flood control projects have taken in response to Federal water policies is presented in the article. Of particular interest are problems with communication which have caused irreversible mistakes in the construction of freshwater marshes and riparian habitat areas.

Keywords: San Francisco Bay, planning, regulations, legal problems, freshwater marsh

89-16. U.S. Department of Commerce (1989), "National Ocean Service Sea and Lake Levels Branch Products and Services Handbook," Sea and Lake Levels Branch, Physical Oceanography Division, Office of Oceanography and Marine Assessment, National Ocean Survey, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Rockville, Maryland.

Products and services available from NOAA are listed in the handbook. Price lists and examples of each product available are included.

Keywords: tides, hydrodynamics

89-17. Williams, P.B. (1989), "An Analysis of Historic Erosion Rates of the Salt Marshes at the Corte Madera Ecological Reserve," Prepared for the Golden Gate Bridge, Highway and Transportation District.

Erosion rates for selected Marin County marshes were determined using historic hydrographic and topographic maps, and aerial photographs. The average erosion rate was determined to be about 2.9 feet per year for the Corte Madera Ecological reserve since 1977. This value is similar to historic erosion rates over the last 136 years. It is concluded that the ferry boats are not the primary cause of erosion at the ecological reserve.

Keywords: San Francisco Bay, erosion control

90-01. Allen, H.H., R.L. Lazor, and J.W. Webb (1990), "Stabilization and Development of Marsh Lands," In R.L. Lazor and R. Medina (eds.), *Beneficial Uses of Dredged Material: Proceedings of the Gulf Coast Regional Workshop, 1988*, pp. 101-112, Technical Report D-90-3, U.S. Army Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi.

Two methods of planting cordgrass (*Spartina alterniflora*) in high energy environments are presented as alternatives to temporary breakwaters for marsh habitat establishment. Paratex erosion control mats and plant rolls can protect plants until they become established in high energy areas.

Keywords: dredge spoil, erosion control, plant establishment

90-02. Coats, R. and P.B. Williams (1990), "Hydrologic Techniques for Coastal Wetland Restoration," In J.J. Berger (ed.), *Environmental Restoration: Science and Strategies for Restoring the Earth*, pp. 236-246, Island Press, Covelo, California.

A general scheme for salt marsh restoration is presented. The Hayward Marsh in San Francisco Bay and the hydraulic model, MPOND, are highlighted in the discussion.

Keywords: San Francisco Bay, hydrodynamics, planning

90-03. Conners, D.H., F. Riesenberg IV, R.D. Charney, M.A. McEwen, R.B. Krone, and G. Tchobanoglous (1990), "Research Needs: Salt Marsh Restoration, Rehabilitation, and Creation Techniques for Caltrans Construction Projects," Prepared for the California Department of Transportation, Division of New Technology, Materials and Research, Sacramento, California.

Areas where further research is needed to successfully conduct salt marsh restoration and creation projects, particularly with respect to Caltrans projects, are identified in the report.

Keywords: planning

90-04. Dinges, C. (1990), "Washington: Wetlands Policy Remains in Limbo," *Civil Engineering*, vol. 60, no. 2, pp. 114.

A brief discussion on the current political climate for Federal wetland policy and legislation is included in the article. A 1982 Congressional Research Service report estimated that 80 percent of the nation's wetlands are not governed by Section 404 of the Clean Water Act. Some controversy exists over the power in the 404 permitting structure given this statistic. Establishment of the North American Wetlands Conservation Council and other federally financed programs are also discussed.

Keywords: regulations, permitting

90-05. Falk, D.A. (1990), "Restoration of Endangered Species: A Strategy for Conservation," In J.J. Berger (ed.), *Environmental Restoration: Science and Strategies for Restoring the Earth*, pp. 328-334, Island Press, Covelo, California.

At least 15 percent of the native flora of the United States are currently at risk of extinction. Projects to restore habitat wherever possible are encouraged.

Keywords: endangered species

90-06. Fonseca, M.S. (1990), "Regional Analysis of the Creation and Restoration of Sea Grass Systems," In J.A. Kusler and M.E. Kentula (eds.), *Wetland Creation and Restoration: The Status of the Science*, pp. 171-194, Island Press, Covelo, California.

An overview of restoration requirements for sea grasses such as *Zostera marina* (eelgrass) is presented in the article.

Keywords: sea grasses, marsh restoration

90-07. Frenkel, R.E. and J.C. Morlan (1990), "Restoration of the Salmon River Salt Marshes: Retrospect and Prospect," U.S. Environmental Protection Agency, Seattle, Washington.

A case study of a salt marsh restoration project in the Salmon River Estuary, Oregon is evaluated after eleven years. Observations and insights are provided for future salt marsh restoration projects in the area.

Keywords: Northern California, tidal marsh, salinity, soil, marsh restoration

90-08. Garbisch, E.W. (1990), "Information Needs in the Planning Process for Wetland Creation and Restoration," In J.A. Kusler and M.E. Kentula (eds.), *Wetland Creation and Restoration: The Status of the Science*, pp. 423-428, Island Press, Covelo, California.

Explicit requirements for draft and final mitigation plans are outlined in the paper.

Keywords: planning

90-09. Hawes, S. (1990), "Beneficial Uses of Dredged Material Within the New Orleans District," In R.L. Lazor and R. Medina (eds.), *Beneficial Uses of Dredged Material: Proceedings of the Gulf Coast Regional Workshop, 1988*, pp. 174-183, Technical Report D-90-3, U.S. Army Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi.

A general overview of Gulf Coast marsh values, problems, and solutions is provided in the paper.

Keywords: dredge spoil, tidal marsh, dredging

90-10. MEC Analytical Systems, Inc. (1990), "Revised Statement of Work to Conduct Monitoring at the Seal Beach National Wildlife Refuge," Submitted to the Port of Long Beach, Long Beach, California.

Monitoring is planned for 30 months to determine if the habitat created is comparable to the habitat at nearby marshes and to the habitat lost as a consequence of the Pier J expansion. Results will be compared to data collected at a reference site and to the project design criteria. Measurement of tide heights, currents, water quality, and plant and animal establishment will be conducted.

Keywords: Southern California, marsh restoration, monitoring

90-11. Minello, T.J. and R.J. Zimmerman (1990), "Creation of Salt Marshes for Fishery Organisms," In R.L. Lazor and R. Medina (eds.), *Beneficial Uses of Dredged Material: Proceedings of the Gulf Coast Regional Workshop, 1988*, pp. 159, Technical Report D-90-3, U.S. Army Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi.

Ongoing research indicates that increasing the marsh/open water interface promotes crustacean and fish production in salt marsh habitats.

Keywords: fish, invertebrates

90-12. Restoring the Earth Staff (1990), "Ecological Restoration in the San Francisco Bay Area: A Descriptive Directory and Sourcebook," Restoring the Earth, Berkeley, California.

Many different types of ecological restoration projects are catalogued and described. Wetland restoration is discussed in chapter eight. Twenty-nine salt marsh projects are described along with seven brackish marsh projects, twelve freshwater marsh projects, and eight projects that use treated wastewater.

Keywords: San Francisco Bay, marsh restoration

90-13. Steinhart, P. (1990), "California's Wild Heritage: Threatened and Endangered Animals in the Golden State," California Department of Fish and Game, Sacramento, California.

The current status of animal species on either the Federal or State endangered and/or threatened species lists is presented.

Keywords: endangered species

90-14. Zimmerman, R.C., J. L. Reguzzoni, S. Wyllie-Echeverria, M.N. Josselyn, and R.S. Alberte (1990), "Assessment of Environmental Suitability for Growth of *Zostera marina* L. (Eelgrass) in San Francisco Bay," in press.

The establishment of criteria to predict the suitability of sites for eelgrass production is attempted based on water turbidity and available light. Specific criteria were not developed, although in clearer water eelgrass may be found as low as -2 m Mean Lower Low Water (MLLW), while in more turbid environments eelgrass is not found below -1 m MLLW.

Keywords: San Francisco Bay, sea grasses, marsh restoration

91-01. Charney, R.D., M.A. McEwen, D.H. Conners, F. Riesenberg IV, R.B. Krone, and G. Tchobanoglous (1991), "Interim Guidance Manual: Salt Marsh Restoration, Rehabilitation, and Creation Techniques for Caltrans Construction Projects in Northern California," Prepared for the California Department of Transportation, Division of New Technology, Materials and Research, Sacramento, California.

The manual includes "how to" information on site assessment, monitoring, planning, design, construction, and operation and maintenance of restored or newly created salt marshes located north of Bodega Bay to the Oregon border. Each chapter includes a checklist of steps that should be carried out. Information on salt marsh plant species, rare and endangered salt marsh animal species, measurement techniques, equipment, structures, and tides is included in the appendixes.

Keywords: Northern California, marsh restoration, planning, construction, maintenance, monitoring, plant establishment, hydrodynamics

91-02. Conners, D.H., F. Riesenberg IV, R.D. Charney, M.A. McEwen, R.B. Krone, and G. Tchobanoglous (1991), "Interim Guidance Manual: Salt Marsh Restoration, Rehabilitation, and Creation Techniques for Caltrans Construction Projects in Southern California," Prepared for the California Department of Transportation, Division of New Technology, Materials and Research, Sacramento, California.

The manual includes "how to" information on site assessment, monitoring, planning, design, construction, and operation and maintenance of restored or newly created salt marshes located north of the Mexico border to Point Conception. Each chapter includes a checklist of steps that should be carried out. Information on salt marsh plant species, rare and endangered salt marsh animal species, measurement techniques, equipment, structures, and tides is included in the appendixes.

Keywords: Southern California, marsh restoration, planning, construction, maintenance, monitoring, plant establishment, hydrodynamics

91-03. McEwen, M.A., D.H. Conners, F. Riesenberg IV, R.D. Charney, R.B. Krone, and G. Tchobanoglous (1991), "Interim Guidance Manual: Salt Marsh Restoration, Rehabilitation, and Creation Techniques for Caltrans Construction Projects in Central California," Prepared for the California Department of Transportation, Division of New Technology, Materials and Research, Sacramento, California.

The manual includes "how to" information on site assessment, monitoring, planning, design, construction, and operation and maintenance of restored or newly created salt marshes located north of Point Conception to Bodega Bay. Each chapter includes a checklist of steps that should be carried out. Information on salt marsh plant species, rare and endangered salt marsh animal species, measurement techniques, equipment, structures, and tides is included in the appendixes.

Keywords: Central California, marsh restoration, planning, construction, maintenance, monitoring, plant establishment, hydrodynamics

91-04. Riesenberg IV, F., R.D. Charney, M.A. McEwen, D.H. Conners, R.B. Krone, and G. Tchobanoglous (1991), "Interim Guidance Manual: Salt Marsh Restoration, Rehabilitation, and Creation Techniques for Caltrans Construction Projects in San Francisco Bay, California," Prepared for the California Department of Transportation, Division of New Technology, Materials and Research, Sacramento, California.

The manual includes "how to" information on site assessment, monitoring, planning, design, construction, and operation and maintenance of restored or newly created salt marshes located in San Francisco Bay. Each chapter includes a checklist of steps that should be carried out. Information on salt marsh plant species, rare and endangered salt marsh animal species, measurement techniques, equipment, structures, and tides is included in the appendixes.

Keywords: San Francisco Bay, marsh restoration, planning, construction, maintenance, monitoring, plant establishment, hydrodynamics

The following paragraphs contain definitions of keywords as applied in this manual. Due to the general nature of many publications on salt marshes, every keyword in the following list might apply to each article in the bibliography. To prevent overuse of keywords on general publications, the keywords that are listed below an article are chosen only if the article provides significant and applicable information in that subject area. Every article in this bibliography has at least one keyword assigned. For information on specific subjects such as birds, dredge spoils, etc., choose the appropriate specific keyword. If more general information is desired on salt marsh dynamics or trophic systems, choose a more general keyword such as Ecology, or Plant Ecology.

Some of the publications listed in the bibliography are specific to a single location, or a specific salt marsh. Generally these publications will be assigned general information keywords and a location keyword (such as San Francisco Bay). In those instances when an article is written about a single location and yet innovative sampling techniques, or exhaustive effort was performed to characterize certain topics (such as bird census, invertebrate identification, etc.), the most significant topics covered in the article will be identified by more specific keywords.

Birds

Publications that contain specific information on bird species or their activity in salt marsh environments are included under the keyword.

27-01, 64-01, 65-04, 69-02, 74-13, 75-11, 76-08, 78-21, 80-13, 81-07, 82-01, 82-04, 83-11, 83-22, 84-10, 84-11, 85-19, 87-13, 89-11

Central California

Central California includes the region from Bodega Bay to Point Conception excluding San Francisco Bay. Significant salt marshes in the Central Region include Elkhorn Slough, Tomales Bay, and Morro Bay. Publications pertaining to the region are included under the keyword.

35-01, 70-01, 70-04, 72-02, 74-05, 75-11, 75-13, 76-20, 77-05, 77-10, 77-11, 78-16, 79-18, 80-10, 80-12, 80-13, 83-09, 84-02, 85-08, 89-02, 91-03

Chemistry and Nutrients

Publications that contain specific information on chemical processes or nutrient processes in salt marsh waters or soils are included under the keyword.

65-02, 72-01, 74-01, 74-17, 75-03, 76-05, 76-16, 76-17, 77-02, 77-14, 77-16, 78-16, 78-19, 78-23, 79-01, 79-17, 79-19, 81-04, 81-05, 82-13, 82-24, 83-04, 83-18, 83-24, 83-25, 86-11, 86-12, 87-05, 88-05, 88-35

Classification

Wetland delineation is the primary focus of this keyword. Publications that deal with the differentiation of freshwater, saltwater, and brackish wetlands, or publications that differentiate between lagoons, tidal wetlands, and seasonal wetlands are also included.

79-08, 83-23, 86-14, 87-01, 87-06, 88-07, 89-01

Construction

Publications that contain information on salt marsh construction are included under the keyword.

66-01, 70-02, 73-03, 74-02, 75-07, 75-08, 76-06, 76-08, 77-12, 77-13, 78-01, 78-02, 78-04, 78-05, 79-13, 79-14, 79-16, 80-09, 82-03, 82-14, 83-16, 83-21, 85-14, 85-16, 85-19, 86-08, 86-09, 87-02, 87-18, 88-33, 89-02, 89-10, 91-01, 91-02, 91-03, 91-04

Construction Equipment

Publications that contain information to assist in the selection or operation of construction equipment for wetland restoration projects are included under the keyword.

73-03, 75-07, 78-02, 85-16, 87-17

Corrosion

The keyword corrosion includes information on the selection of metals compatible with marine environments or information on active and passive corrosion control methods.

66-01, 70-02, 75-08, 79-13, 86-08

Dredge Spoil

Publications that contain information on past successes and failures in dealing with dredge spoils in marsh restoration projects are included under the keyword.

72-07, 74-14, 74-18, 75-02, 75-07, 76-04, 76-07, 77-13, 77-15, 77-16, 78-06, 78-13, 78-14, 78-18, 78-20, 78-21, 78-22, 80-07, 82-03, 83-02, 83-20, 84-01, 85-20, 88-39, 90-01, 90-09

Dredging

Publications in the bibliography in which dredging operations are described are included under the keyword.

74-07, 75-06, 75-07, 77-02, 77-15, 78-06, 78-18, 81-01, 83-08, 83-17, 83-20, 87-17, 90-09

Ecology

Publications that contain information on interactions between the physical environment, plants, and animals in the salt marsh are included under the keyword. More specific information on plants can be found by using the keyword Plant Ecology.

35-01, 66-03, 70-03, 70-04, 70-05, 70-06, 72-02, 73-02, 73-06, 73-07, 74-05, 74-06, 74-09, 74-10, 74-12, 74-16, 75-09, 75-13, 76-01, 76-09, 76-10, 76-14, 76-15, 76-18, 76-19, 76-20, 76-22, 77-04, 77-09, 77-10, 78-07, 78-12, 78-13, 79-06, 79-10, 79-14, 79-15, 79-18, 80-10, 80-11, 81-09, 81-12, 82-12, 82-27, 83-08, 83-09, 83-14, 83-18, 83-19, 83-24, 83-25, 85-04, 86-03, 86-09, 86-14, 86-19, 87-08, 87-22, 88-04, 88-11, 88-19, 88-26, 88-45, 89-02, 89-12

Economic Value

Publications in which the author has attempted to provide information on the economic value of salt marsh and other wetlands are included under the keyword.

78-15, 82-12, 83-01, 83-06, 83-26, 87-08, 87-16, 88-19

Endangered Species

The keyword describes publications or project reports on the status of endangered salt marsh species. Publications in which restoration efforts with endangered species habitat enhancement as a major goal are also included under the keyword.

27-01, 65-03, 76-24, 77-18, 79-03, 79-10, 80-03, 80-13, 82-19, 84-10, 85-19, 87-07, 87-21, 88-24, 90-05, 90-13

Erosion Control

The use of salt marsh for erosion control is commonly practiced on the East and Gulf Coasts of the U.S. Publications on the use of salt marsh vegetation for erosion control on the East, Gulf, and the West Coasts are included under the keyword.

75-04, 75-05, 75-15, 77-05, 79-12, 83-01, 83-02, 83-15, 84-01, 84-02, 84-06, 84-13, 85-08, 87-05, 89-17, 90-01

Fish

Publications that contain information on fish species found in salt marshes and estuaries are included under the keyword.

72-04, 75-01, 77-11, 81-06, 81-07, 82-01, 82-04, 86-18, 87-13, 87-26, 90-11

Freshwater Marsh

Although not the primary focus of the bibliography, many publications contain information on freshwater marshes and brackish marshes, these publications are included under the keyword.

74-07, 75-09, 75-13, 76-08, 76-14, 76-20, 76-21, 77-07, 77-10, 77-14, 78-08, 78-09, 78-12, 79-06, 80-04, 80-11, 81-12, 81-13, 82-22, 82-25, 83-01, 83-06, 83-24, 84-02, 84-04, 85-04, 86-02, 86-03, 86-15, 87-10, 88-02, 88-04, 88-16, 88-31, 88-33, 89-14, 89-15

Geomorphology

Publications dealing with marsh geomorphology, the science of interaction between hydraulic, geologic, and soil systems are included under the keyword.

65-05, 75-15, 83-18, 83-25, 84-13, 85-02, 85-07, 86-05, 88-08, 88-40

Hydrodynamics

Publications that contain information on hydraulics and hydraulic modeling are included under the keyword.

00-01, 42-01, 51-01, 58-01, 65-06, 68-01, 71-01, 72-05, 73-04, 74-10, 74-15, 75-10, 75-14, 76-13, 78-10, 79-07, 80-04, 80-14, 81-12, 82-11, 82-17, 83-01, 83-03, 83-04, 83-05, 83-07, 83-08, 83-13, 83-21, 83-23, 83-28, 83-29, 84-07, 84-13, 84-16, 85-10, 85-12, 85-14, 86-05, 86-07, 86-13, 86-14, 86-17, 86-20, 87-04, 87-09, 87-12, 87-29, 87-30, 88-10, 88-14, 88-18, 88-21, 88-22, 88-38, 88-43, 89-06, 89-09, 89-13, 89-16, 91-01, 90-02, 91-02, 91-03, 91-04

Insects

Publications that contain information on insect species or their interaction in salt marshes are included under the keyword.

72-03, 74-04, 74-08, 75-10, 76-03, 80-01, 82-01, 82-04, 82-26, 88-05, 88-30

Inventory

Publications in which the primary focus is on assessing the inventory of salt marsh, freshwater marsh, and brackish marsh acreage are included under this keyword. Some inventories are nation wide, some are state wide, and some are regional or locally oriented.

59-01, 70-05, 73-02, 73-06, 74-05, 74-09, 74-10, 74-16, 75-09, 75-13, 76-01, 76-09, 76-10, 76-14, 76-15, 76-18, 76-20, 76-22, 77-03, 77-04, 77-09, 77-10, 80-05, 80-11, 82-08, 82-18, 82-22, 84-08, 85-02, 86-02, 86-14, 87-23, 89-07

Invertebrates

Invertebrates described in most publications included under this keyword are marine species.

67-02, 69-01, 71-02, 76-04, 77-11, 81-06, 81-07, 82-01, 82-04, 82-23, 84-17, 85-15, 87-11, 87-26, 88-23, 90-11

Lagoon

Publications that contain information on seasonal lagoons, as found along the north and south coast of California are included under the keyword.

70-04, 72-01, 72-06, 74-06, 74-10, 75-09, 76-01, 76-15, 79-04, 83-24, 89-10, 89-12

Legal Problems

Publications that contain information on legal problems or precedent that have occured along tidal boundaries or as a result of salt marsh restoration are included under the keyword.

79-02, 82-09, 83-05, 85-03, 87-08, 88-09, 89-15

Maintenance

Information on maintenance requirements or innovative maintenance programs for managed tidal marshes is included under the keyword.

66-01, 70-02, 74-04, 74-08, 75-08, 77-06, 79-13, 81-13, 82-07, 82-16, 82-26, 82-27, 83-03, 83-08, 83-13, 83-16, 83-21, 85-13, 86-08, 86-17, 88-06, 88-30, 91-01, 91-02, 91-03, 91-04

Mammals

Publications in which information describing mammals found in salt marshes are included under the keyword.

65-03, 76-24, 77-18, 82-04, 82-19, 84-10, 84-11

Marsh Restoration

Publications in which salt marsh restoration efforts are described or in which the requirements for restoration are identified are included under this keyword.

74-02, 74-03, 74-07, 74-18, 75-02, 75-04, 75-07, 75-12, 76-04, 76-06, 76-07, 76-08, 77-03, 77-04, 77-07, 77-12, 77-13, 78-01, 78-02, 78-04, 78-06, 78-10, 78-11, 78-13, 78-14, 78-18, 78-20, 78-21, 79-04, 79-05, 79-06, 79-09, 79-10, 79-12, 79-15, 79-20, 80-02, 80-09, 81-06, 81-07, 81-09, 82-02, 82-05, 82-08, 82-09, 82-16, 82-17, 82-21, 82-22, 82-28, 83-13, 83-14, 83-16, 83-20, 83-26, 83-27, 83-29, 84-02, 84-03, 84-04, 84-06, 84-14, 84-15, 85-01, 85-13, 85-14, 85-20, 86-03, 86-04, 86-07, 86-09, 86-10, 86-13, 86-15, 86-17, 87-02, 87-04, 87-06, 87-09, 87-10, 87-11, 87-12, 87-13, 87-15, 87-17, 87-18, 87-22, 87-24, 87-28, 87-31, 87-33, 88-09, 88-10, 88-14, 88-15, 88-17, 88-18, 88-20, 88-22, 88-25, 88-28, 88-31, 88-32, 88-33, 88-38, 88-39, 88-40, 88-41, 88-43, 88-44, 88-45, 89-02, 89-04, 89-05, 89-06, 89-10, 89-11, 89-14, 91-01, 91-02, 90-06, 90-07, 91-03, 90-10, 90-12, 91-04, 90-14

Mitigation Banks

Publications that contain guidelines for mitigation banks or in which applications of this innovative economic technique are described are included under the keyword.

82-16, 85-05, 87-20, 87-25, 88-14

Monitoring

Publications that contain monitoring requirements and practices in existing and proposed salt marsh projects are included under the keyword.

64-01, 65-04, 66-04, 67-01, 71-02, 72-01, 72-04, 73-04, 73-05, 74-13, 75-04, 75-10, 75-15, 76-04, 76-23, 77-11, 78-01, 78-02, 78-18, 78-21, 79-09, 80-10, 81-06, 81-09, 81-10, 82-01, 82-05, 82-28, 83-18, 83-22, 83-28, 84-03, 84-06,

84-11, 85-02, 85-09, 85-20, 86-07, 86-11, 86-12, 86-13, 86-18, 87-11, 87-14, 87-18, 87-23, 87-31, 87-32, 88-05, 88-06, 88-07, 88-10, 88-16, 88-28, 88-35, 88-41, 88-43, 89-10, 91-01, 91-02, 91-03, 90-10, 91-04

Mosquito Control

Publications that contain specific information on mosquito control efforts in salt marshes as well as general publications on mosquito control are included under the keyword.

74-04, 74-08, 75-10, 77-12, 82-26, 83-03, 83-21, 86-05, 88-30

Northern California

The Northern California biogeographic region extends from the Oregon border to just north of Bodega Bay along the California Coast. Examples of large salt marshes in Northern California can be found in Humboldt Bay, near Big River, and in the Smith River Delta. Publications that specifically pertain to this region are included under the keyword.

73-06, 73-08, 74-09, 75-09, 80-11, 80-12, 81-08, 81-10, 81-12, 82-01, 83-09, 83-24, 83-25, 84-04, 84-11, 85-01, 85-08, 85-17, 87-02, 87-08, 87-21, 88-14, 88-31, 91-01, 90-07

Permiting

Salt marsh literature dealing with permiting practice and requirements are included under this keyword. It should be noted that the material contained in these publications is important for determining the requirements of different regulating agencies, but is dated and, therefore, must always be used with caution.

76-02, 77-02, 78-17, 79-10, 79-18, 80-02, 80-11, 82-09, 82-20, 83-09, 84-08, 85-03, 85-04, 85-05, 85-08, 87-01, 87-02, 87-03, 87-08, 87-24, 87-25, 87-28, 88-02, 88-03, 88-13, 88-36, 88-37, 89-01, 89-03, 90-04

Planning

The planning keyword includes publications in which the many planning issues and activities required to implement salt marsh restoration projects are described.

69-03, 70-05, 74-02, 74-12, 74-16, 75-10, 76-06, 76-07, 77-03, 77-12, 78-13, 78-15, 78-20, 78-22, 79-18, 80-11, 81-01, 82-02, 82-07, 82-08, 82-16, 82-18, 82-20, 82-21, 82-22, 82-29, 83-06, 83-16, 83-21, 83-26, 83-27, 84-08, 84-14, 85-01, 85-13, 85-19, 86-03, 86-09, 86-15, 86-16, 86-17, 87-01, 87-03, 87-04, 87-06, 87-07, 87-15, 87-19, 87-20, 87-25, 87-33, 88-04, 88-08, 88-09, 88-12, 88-19, 88-31, 88-34, 88-36, 88-43, 89-04, 89-14, 89-15, 91-01, 90-02, 90-03, 91-02, 90-08, 91-03, 91-04

Plant Ecology

Publications dealing with plant interactions, plant zonation, and other aspects of plant survival in natural and manmade salt marshes are included under the keyword.

42-01, 58-02, 65-05, 66-04, 69-02, 70-01, 71-03, 72-05, 73-01, 73-05, 75-14, 76-11, 76-12, 76-13, 77-04, 77-06, 77-08, 77-17, 78-18, 78-23, 79-01, 80-14, 81-03, 81-11, 82-06, 82-13, 83-03, 83-10, 84-05, 84-11, 85-06, 85-07, 85-17, 86-01, 86-20, 87-05, 87-07, 87-10, 87-21, 88-29

Plant Establishment

Publications dealing with the necessary steps required for planning and implementing vegetation establishment in salt marsh restoration efforts are included under the keyword.

42-01, 70-01, 72-07, 73-07, 74-07, 74-11, 74-18, 75-02, 75-04, 75-05, 75-12, 76-11, 76-12, 76-13, 77-03, 77-05, 77-06, 78-01, 78-02, 78-06, 78-10, 78-11, 78-14, 78-18, 78-21, 78-22, 79-09, 79-12, 79-20, 80-07, 80-08, 80-09, 81-07, 82-05, 82-10, 82-15, 82-28, 83-02, 83-03, 83-13, 83-15, 84-01, 84-03, 84-05, 84-06, 84-09, 84-14, 85-20, 86-01, 86-04, 86-06, 86-07, 86-13, 86-20, 87-06, 87-21, 87-30, 87-31, 88-14, 88-39, 89-08, 90-01, 91-01, 91-02, 91-03, 91-04

Regulations

Specific regulations and requirements of regulatory agencies on past restoration efforts are included under the keyword.

74-14, 76-18, 79-02, 79-05, 79-08, 79-18, 81-01, 83-05, 83-08, 83-10, 84-08, 87-15, 87-28, 87-33, 88-02, 88-09, 88-34, 88-37, 88-42, 89-01, 89-03, 89-15, 90-04

Salinity

The keyword salinity refers to publications dealing with water and soil salinity in salt marshes.

42-01, 66-02, 69-02, 70-01, 71-03, 72-01, 76-12, 76-15, 77-11, 78-18, 78-19, 80-06, 80-14, 81-11, 83-07, 83-12, 83-18, 83-23, 84-15, 84-16, 84-17, 85-12, 85-20, 86-19, 86-20, 87-30, 89-13, 90-07

San Francisco Bay

The San Francisco Bay biogeographic region extends from the Golden Gate to the Sacramento-San Joaquin Delta including San Francisco Bay, San Pablo Bay, and Suisuin Bay. Publications that pertain to this region are included under the keyword.

27-01, 59-01, 62-01, 65-03, 65-05, 66-03, 69-02, 70-05, 72-03, 72-05, 73-01, 74-12, 75-14, 76-03, 76-07, 76-11, 76-12, 76-13, 76-18, 76-19, 76-24, 77-02, 77-03, 77-04, 77-05, 77-09, 77-12, 77-15, 77-18, 78-01, 78-10, 78-14, 79-01, 79-07, 79-09, 79-10, 79-11, 79-12, 80-01, 80-12, 80-13, 81-07, 81-11, 82-05, 82-16, 82-17, 82-18, 82-19, 82-20, 83-03, 83-09, 83-13, 83-14, 83-19, 83-21, 84-03, 84-05, 84-06, 84-07, 84-10, 84-12, 85-02, 85-03, 85-05, 85-13, 85-14, 85-17, 86-05, 86-07, 86-10, 86-13, 86-18, 87-05, 87-06, 87-09, 87-13, 87-16, 87-17, 87-19, 87-20, 87-23, 87-28, 87-30, 88-03, 88-10, 88-21, 88-22, 88-23, 88-27, 88-30, 88-32, 89-05, 89-07, 89-11, 89-15, 89-17, 90-02, 90-12, 91-04, 90-14

Sea Grasses

Publications dealing with the ecology and restoration of sea grasses such as eel grass (*Zostera* sp.), that occur below the mean low water line are included under the keyword.

74-11, 80-08, 82-15, 90-06, 90-14

Sea Level Rise

Publications that contain predictions of sea level rise and the impact of potential sea level rise are included under the keyword.

51-01, 85-10, 85-18, 87-19

Sedimentation

Publications in which sedimentation processes, rates, or impacts are identified and described are included under the keyword.

62-01, 65-05, 66-02, 70-06, 71-01, 72-05, 72-06, 73-06, 74-09, 74-10, 75-15, 76-09, 76-10, 77-01, 77-02, 77-08, 78-03, 78-10, 79-11, 79-15, 81-08, 81-12, 82-11, 83-01, 83-17, 83-28, 83-29, 84-02, 84-03, 84-04, 84-06, 84-13, 85-07, 85-10, 85-14, 85-18, 86-07, 87-04, 87-05, 87-19, 87-22, 88-10, 88-22, 89-12

Soil

Publications that contain information on marsh soils are included under the keyword. Characterization of both natural and introduced soils and soil modification efforts are described.

58-02, 65-01, 65-02, 66-02, 67-01, 69-02, 73-01, 74-01, 74-17, 75-04, 75-07, 75-15, 76-04, 76-13, 76-16, 76-17, 76-23, 77-12, 77-15, 78-18, 78-19, 79-09, 79-16, 80-14, 81-05, 81-07, 82-03, 82-05, 82-11, 82-13, 82-14, 83-04, 83-15, 83-18, 83-21, 83-29, 84-03, 85-07, 85-10, 85-11, 87-05, 88-05, 88-18, 88-35, 88-42, 89-13, 90-07

Southern California

The Southern California biogeographic region extends from Point Conception to the Mexican border along the California Coast. Examples of large salt marshes in Southern California include Tijuana Estuary and the Ballona Wetlands. Publications containing information pertaining to the region are included under the keyword.

42-01, 58-02, 66-02, 66-04, 69-03, 70-03, 70-06, 71-03, 72-01, 72-06, 73-02, 74-02, 74-03, 74-10, 75-01, 76-01, 76-09, 76-10, 76-14, 76-15, 76-22, 77-17, 78-16, 79-04, 79-05, 79-06, 80-09, 80-12, 80-13, 80-14, 81-03, 81-06, 81-09, 82-02, 82-22, 82-27, 83-09, 84-14, 84-15, 84-16, 84-17, 85-06, 85-08, 85-19, 85-20, 86-03, 86-15, 86-16, 86-17, 86-19, 86-20, 87-07, 87-10, 87-11, 87-18, 87-22, 87-31, 88-20, 88-26, 88-38, 88-41, 88-43, 88-44, 89-12, 89-14, 91-02, 90-10

Structures

The keyword includes publications in which manmade hydraulic structures such as breakwaters, dikes, levees, culverts, inverted siphons, weirs, revetments, gabions, sand bags, etc. are described.

66-01, 70-02, 75-08, 78-05, 79-13, 82-11, 83-02, 84-01, 84-13, 86-15, 86-17, 87-17, 87-19, 88-38, 89-11

Tidal Marsh

The principal focus of the bibliography is tidal salt marshes. Tidal marshes are heavily influenced by the tides year-round as opposed to lagoons, or brackish marshes and seasonal marshes.

35-01, 42-01, 58-02, 65-05, 66-03, 66-04, 67-02, 69-01, 69-03, 70-01, 70-03, 72-02, 72-07, 73-02, 73-06, 73-07, 74-03, 74-04, 74-05, 74-07, 74-08, 75-02, 75-03, 75-09, 75-13, 75-14, 76-03, 76-06, 76-07, 76-11, 76-12, 76-13, 76-14, 76-18, 76-20, 77-03, 77-04, 77-05, 77-06, 77-09, 77-10, 77-11, 77-16, 77-17, 78-12, 78-18, 78-19, 78-23, 79-01, 79-05, 79-06, 79-17, 79-18, 79-19, 80-01, 80-04, 80-05, 80-09, 80-10, 80-11, 81-05, 81-06, 81-07, 81-08, 81-11, 81-12, 82-01, 82-02, 82-04, 82-06, 82-12, 82-13, 82-16, 82-22, 82-23, 82-24, 82-27, 83-01, 83-03, 83-06, 83-14, 83-16, 83-18, 83-24, 83-25, 84-02, 84-04, 84-06, 84-07, 84-11, 84-17, 85-03, 85-04, 85-07, 85-13, 85-17, 85-18, 86-02, 86-03, 86-04, 86-15, 86-19, 86-20, 87-05, 87-09, 87-10, 87-11, 87-13, 87-22, 87-24, 87-26, 87-28, 87-30, 88-02, 88-04, 88-14, 88-15, 88-18, 88-31, 88-39, 88-44, 89-05, 89-07, 89-10, 89-12, 89-13, 89-14, 90-07, 90-09

Tides

The keyword includes publications in which tidal actions are described and methods for measuring the tides are identified.

00-01, 51-01, 58-01, 65-06, 68-01, 73-04, 74-15, 82-17, 83-07, 84-12, 89-09, 89-16

Wastewater Treatment

Publications that contain information on the treatment of stormwaters and wastewaters by wetlands are included under the keyword.

72-01, 73-07, 76-05, 76-21, 76-23, 77-14, 77-16, 78-03, 78-08, 78-09, 79-14, 81-02, 82-23, 82-25, 83-13, 83-16, 86-13, 87-27, 88-01

Water Quality

The keyword water quality includes publications in which general practices in water quality monitoring and characterization in salt marsh systems are described.

58-02, 72-01, 73-02, 73-06, 73-07, 74-14, 74-17, 75-03, 76-05, 76-15, 76-17, 76-23, 77-11, 77-14, 77-15, 78-09, 78-18, 79-17, 79-19, 81-04, 81-05, 82-13, 82-23, 82-24, 82-26, 83-01, 83-04, 83-17, 83-18, 86-14, 86-20, 88-14, 89-12